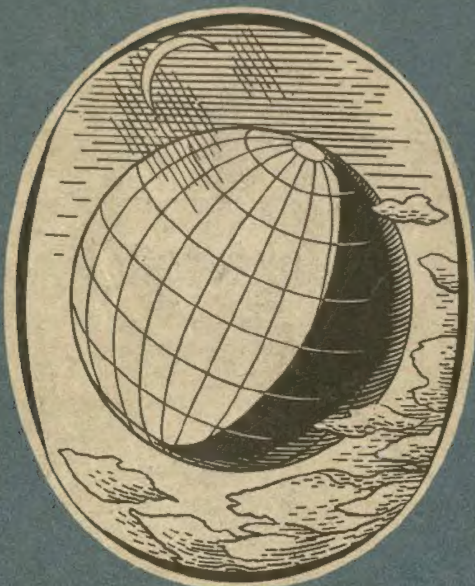
OXFORD JUNIOR ENCYCLOPAEDIA

VOLUME III • THE UNIVERSE



OXFORD JUNIOR ENCYCLOPAEDIA

Volume III

THE UNIVERSE

The subject of this volume is the Physical Universe—the vast background against which living things of every kind play their part. It tells of the different heavenly bodies, nebulae, stars, planets, and suns, and of the laws which govern phenomena such as time, space, light, and sound. It describes the earth, its history, the materials of which it consists (geology), the atmosphere which surrounds it (weather), and the physical features of its surface, such as mountains, oceans, deserts, glaciers, and quicksands. It also accounts for such strange phenomena as mirages, Aurora Borealis, rainbows, earthquakes, tornadoes, and geysers. It gives a short account of every country and of some of the principal and most interesting towns. In short, it describes the physical environment of the people described in Volume I and the plants and animals described in Volume II.

The Encyclopaedia will be completed in twelve separate volumes, each dealing with one subject-group, and each complete and independent in itself from A to Z, though the volumes will be linked by cross-references. Plan of the volumes:—

Vol. I. MANKIND (published)
II. NATURAL HISTORY (published)
III. THE UNIVERSE (published)
IV. COMMUNICATIONS (published)
V. GREAT LIVES
VI. FARMING AND FISHERIES
VII. INDUSTRY AND COMMERCE
VIII. ENGINEERING
IX. RECREATIONS (published)
X. LAW AND ORDER
XI. THE HOME
XII. THE ARTS

A GENERAL INDEX volume will complete the series.

Price 2

OXFORD JUNIOR ENCYCLOPAEDIA

VOLUME III

THE UNIVERSE

/e

OXFORD JUNIOR ENCYCLOPAEDIA

GENERAL EDITORS
LAURA E. SALT & GEOFFREY BOUMPHREY
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VOLUME III

THE UNIVERSE

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PREFACE

IN authorizing the preparation of this work the Delegates of the Oxford University Press had foremost in mind the need to provide a basic book of reference for school libraries. In form it was to be a genuine encyclopaedia, in treatment and vocabulary suitable for the young reader. To many children (and indeed to many adults) reading is not a natural activity: they do not turn to books for their own sake. But they can be trained to go to books for information which they want for some particular purpose—and thus, very often, to form a habit which will be of lifelong value. Their capacity to read continuously for any length of time being limited, they can absorb knowledge better if they get it in small quantities: therefore they will often read reference books when they may reject the reading of more extended matter. Again, it is probably true to say of such readers that their approach is from the particular to the general, and from the application to the principle, rather than the reverse, that their main interest is in the modern world around them, and that since they are not very good at conceiving things outside their own experience, their capacity for grasping abstract ideas is limited. On the other hand, once their interest is aroused, they will often pursue a subject to remarkable lengths, so long as its development is logical and the treatment avoids dullness.

But such generalizations can easily be overdone: many children using the books will not be of this type. Moreover, it was evident from the first that a project involving so great an amount of work, however exactly it might meet its principal mark, would be fully justified only if it could be of service to a far wider circle of readers. Even for the age-group first in mind, anything like 'writing down to children' must plainly be taboo—but clear exposition and simple language are no bad qualities in writing for any audience. Here, then, it seemed was the opportunity to provide a work of reference suitable for many readers to whom the large, standard encyclopaedias are too heavy and technical, and the popular alternatives for the most part neither sufficiently complete nor authoritative. The fact that the plan allowed for an exceptionally large proportion of illustrations to text (between one-quarter and one-third of the total space) is an advantage to any reader, since pictures may, in many instances, save whole paragraphs of involved explanation. With these secondary aims well in mind, then, the General

Editors have ventured to hope that the encyclopaedia may find usefulness not only among certain younger children, but also among older students in clubs, libraries, and Young People's Colleges, and even to no small extent among their parents and other adults who may wish for a simple approach to some unfamiliar or forgotten subject.

SCOPE AND EMPHASIS. Within certain limits the OXFORD JUNIOR ENCYCLOPAEDIA purports to be reasonably comprehensive, though (in common with all general encyclopaedias) not exhaustive. Chief among these limits is that matter already easily available in school text-books is included only so far as its presence is necessary for the proper understanding of the subject under discussion. Thus, although an immense field of history is surveyed, it will be found mainly under headings dealing with its effects, or in the biographies of those who lived to make it. Purely technical or scientific subjects, also, are omitted except when they have some general interest. In natural history and kindred studies the immense variety of forms necessarily led at times either to their treatment by groups or to their omission on purely arbitrary decisions as to which species would, in all probability, never be looked for, or because there was nothing particularly interesting to say of them. In point of general balance the stress is laid rather on the modern world, though due space is given to the factors which have shaped it, no less than to those which are changing it.

ARRANGEMENT. The encyclopaedia is planned to consist of twelve volumes. Each is arranged alphabetically within itself, and each deals with a particular range of related subjects. Within its terms of reference, then, each volume is virtually self-contained, and, owing to the great number of single-line cross-references, can well be used alone. This arrangement, which has several incidental advantages (as of production, in difficult times, and of prompt revision later), arose mainly from one consideration. If articles were to be kept really short—and, in fact, few approach and almost none exceeds 2,000 words—many subjects could be dealt with comprehensively only by referring the reader to other relevant articles—itself a desirable thing to do. It was clearly preferable for these to be under his hand, rather than be dispersed through any of the twelve volumes at the caprice of the alphabet. This the present arrangement achieves to a great extent. If it has led to a small amount of overlapping, that again is not without its advantages.

Cross-references, then, play an indispensable part in the make-up of the encyclopaedia. They are of two kinds: references in the text to further articles amplifying the particular point under review, and references at the end of an article to others taking the whole subject farther. Therefore, a reader looking up any wide subject, such as ASTRONOMY, and following up its cross-references either in the text or at the end of the article, can discover under what main headwords the subject is treated. These, again, will refer him to any subsidiary articles, as also, in many cases, to those of a complementary nature. Thus he may be guided either from the general to the particular or vice versa. It is believed that the titles of the twelve volumes (see p. xii), in conjunction with their sub-titles, will usually lead the reader straight to the volume containing the information he wants. In selecting headwords, the rules generally followed have been to prefer the familiar, or even the colloquial, reserving the technical alternative for a single-line entry, and to group narrow subjects under a headword of wider scope. Thus, for HUMIDITY, *see* WATER VAPOUR; for PAMPAS or SAVANNAH, *see* GRASSLANDS; for GOBI DESERT, *see* DESERTS; and for MARS, *see* PLANETS, section 3.

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OXFORD, 1949

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COLOUR PLATES

PLAN OF VOLUMES

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EVOLUTION
ANCIENT WORLD
RACES AND NATIONS
RELIGIONS
MYTHOLOGY
FOLK-LORE

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XII. THE ARTS
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DRAMA
MUSIC
PAINTING
SCULPTURE
ARCHITECTURE

GENERAL INDEX VOLUME
Covering entries in all 12 volumes

HOW TO USE THIS BOOK

THIS VOLUME is one of twelve, each on a separate subject, the whole set forming what is called an encyclopaedia, or work from which you can find out almost anything you want to know. (The word comes originally from the Greek *enkuklios*, circular or complete, and *paideia*, education.) Each of the twelve volumes is arranged alphabetically within itself, as twelve dictionaries would be.

The difference between a dictionary and an encyclopaedia is that while the first gives you no more than the meanings and derivations of words, the second tells you a very great deal more about their subjects. For instance, from a dictionary you could learn that a HAIL-STONE is a pellet of frozen water, and little more; but an encyclopaedia will tell you how and why hail-stones are built up in layers, like an onion, that sometimes insects are found frozen inside them—and many other things about them. Then a dictionary contains nearly every word in the language; but an encyclopaedia deals only with words and subjects about which there is something interesting to be said, beyond their bare meanings. So you should not expect to find every word in an encyclopaedia—every subject is there, but not every word.

To find any subject, you have first to decide in which of the twelve volumes it comes. Each of these has a title as well as a number, and also a list of general subjects to make the title clearer. All these are set out in the Plan of Volumes on the opposite page. Very often you will be able to tell from the title alone which volume contains the information you need; but if not, the list of sub-headings on the plan opposite will help to direct you. For example, if you want to find out about an animal or plant, you would look it up in Volume II, Natural History; but if you wanted to know how that animal or plant is used in something like farming, fishing, or trapping, you would find it in Volume VI. If your subject were something in nature that does not have life—such as the sun, or a particular country or river, or a kind of stone—you would find it in Volume III, with tides, earthquakes, the weather, and many other things. Matters connected with communication of any kind—of people, or goods, or even of ideas—are in Volume IV. So you would look there for languages, and printing, and broadcasting, as well as for ships, and trains, and roads. But if it is the engineering side of any of these things that interests you, Volume VIII, Engineering, is the place to try.

Business and trade are in Volume VII; and how we are governed and protected by the State, the law, and the armed forces is in Volume X. All kinds of sport and games, as well as hobbies and more important crafts are in Volume IX; and Volume XI deals with almost everything connected with our homes, from the building and furnishing of the house to the clothes and health of those who live in it. The titles of Volumes V and XII, Great Lives and The Arts, explain themselves; and a rather fuller account of the volume you are reading now is given on page xv.

To find your subject in the volume, think of its ordinary name, and then look it up just as though you were using a dictionary—the As on the first page and the Zs (if there are any) on the last. If you cannot find it, try a more general word. For instance, if you want to read about Samoa, the South Sea island, and cannot find it under its name (as you cannot), try either PACIFIC ISLANDS or SOUTH SEA ISLANDS—either of which will lead you to it. As you read any article, you will probably come across the titles of other articles in some way connected with what you are reading. You will know that they are titles of other articles because they will be printed in capital letters. Either they will be followed by (q.v.) in brackets (this is short for the Latin *quod vide*, and means 'which see'), or else they themselves will be in brackets, with the word *see* in front of them. You can look up these other articles at once if you want to know more about the particular point dealt with, or you can save them up until you have finished the article you are reading. At the end of any article you may find the words 'See also', followed by one or more titles in small capital letters. If you look these titles up, they will tell you still more about the subject that interests you. These last 'cross-references' are very useful if you want to look up a particularly wide subject (such as GEOLOGY or WEATHER), because they show you at once the titles of all the main articles dealing with it. You can then decide for yourself which to read.

WHAT YOU WILL FIND IN THIS VOLUME

THIS VOLUME IS ABOUT THE UNIVERSE, THE VAST BACKGROUND AGAINST WHICH LIVING THINGS OF EVERY KIND PLAY THEIR PARTS

THE HEAVENS. You can read of the unimaginable expanses of SPACE, and of the different heavenly bodies scattered about in it—NEBULAE, STARS, SUNS, and PLANETS, all held in their courses by the power of GRAVITATION—and of those far smaller objects which we see as shooting stars or METEORS. You can read of the almost incredible amount of knowledge as to their natures, positions, and movements possessed by ASTRONOMY, knowledge won by the patient observations and calculations of star-watchers since long before the earliest page of written history.

THE EARTH. To a great extent the story of our own Earth is told in the ROCKS that make up its crust—just as the story of the living things on and under its surface is to a great extent told by the FOSSILS found in the rocks. In this volume, then, you will find something of what GEOLOGY can teach of the vast movements of the Earth's crust that have resulted in MOUNTAIN BUILDING and CONTINENTAL DRIFT, of the wearing away or DENUDATION of its surface by wind and water, FROST and ice (in the form of GLACIERS). Here are described, too, the MINERALS composing the rocks, and the METAL ORES and PRECIOUS STONES so prized by man. You can read of EARTHQUAKES and VOLCANOES, CORAL ISLANDS and CAVES, QUICKSANDS and AVALANCHES, MIRAGES, RAINBOWS, and the beautiful AURORA BOREALIS. If you wish to learn about WEATHER FORECASTING, you will find an article here, and others dealing with such kindred matters as WINDS and CLOUDS, RAIN, FOG and SNOW, THUNDERSTORMS, and even TORNADOES.

COUNTRIES AND TOWNS. The Earth's surface is divided up to some extent by natural features such as OCEANS, RIVERS, DESERTS, and mountain ranges. But man himself has divided it further into countries, states, and provinces. You will find articles about these, describing the type of country found in each, the CLIMATE, the vegetation, and the main products. The principal towns are given separate articles, outlining their history, their environment, and their circumstances to-day.

EXPLAINING THE UNIVERSE. To help you to a fuller understanding of much of the above, you will find articles on such things as SOUND, HEAT, and MOTION. You can read, too, in RADIATION of those waves through space which reach us in such different forms as X-rays, wireless waves, radiant

heat, and LIGHT. And here you will be treading very newly explored ground: for within our own century science has moved farther towards a truer understanding of MATTER and the forces affecting it than in all the centuries before. Reading on, then, you will find articles outlining the newer views on the ATOM, with their far-reaching effects on our understanding of CHEMISTRY, ELECTRICITY, and much else. Finally, you can read how the theory of RELATIVITY has upset all our previous views on SPACE and TIME.

The words in capitals are the headings of some of the general articles.

A

ABYSSINIA (ETHIOPIA). This country forms part of the east horn of Africa (*see* Map, p. 5). It has very strong natural defences, for it lies on a gigantic plateau which rises in some places almost sheer for as much as 8,000 feet above the surrounding country. Here and there the cliff edge of the plateau has been cut by watercourses, which are filled by torrents in the rainy seasons, but are completely dry at other times. For hundreds of years these watercourses were the only roads linking Abyssinia with the outer world.

Gaunt stony mountain ranges rise steeply above the Abyssinian plateau, and much of this barren, mountainous land is still largely unexplored. The plateau is cut by rift-valleys, some of which are thousands of feet deep, some fertile and many miles in extent, and others short and only a few hundred feet wide. In the centre of the country are the *ambas*—curiously shaped conical hills which look as if they had had their tops cut off. From a distance they appear to be enormous forts, and many of them have, in fact, been made into forts or prisons. In the north and central highlands there are large stretches of country with coarse grass and occasional thickets and thorn trees. In the south-west there are magnificent forests.

As the whole country slopes down slightly to the west, most of the rivers flow into the Nile valley. In the north the River Takazzi flows for part of its course in a great ravine 7,000 feet deep, and eventually joins the Nile. The most important river, the Blue Nile or Abai, flows north-west out of Lake Tana and joins the White Nile at Khartoum (*see* NILE). The only two rivers which run east lose themselves in the coastal deserts and never reach the sea.

In most of Abyssinia there are clearly defined rainy seasons. In February and March come the 'little rains', and from the middle of June to the middle of September are the 'great rains'. Until all-weather roads were built by the Italians during their period of occupation, trading had to stop during these months. Transport was carried on entirely by pack-animals, who followed paths along the dry beds of water-courses; but when the wet seasons turned these into foaming rivers—the Takazzi rises as much as 70 feet in the rains—movement was no longer possible. Temperature depends on altitude. The Danakil Desert is below the level of the Red Sea, and is very, very hot, whereas some of the mountain peaks have perpetual snow. On most of the plateau the temperature is like that of a very hot English summer day, though the nights are bitterly cold.

Much of Abyssinia is very fertile, and in some parts there are two crops a year. Agriculture,

THE ARUSA COUNTRY—A WIDE VALLEY IN THE ABYSSINIAN PLATEAU
Royal Geographical Society

however, is primitive. The land is merely scratched by a long pole with two prongs, drawn by oxen, and the grain is threshed by men with flails. One of the most important products is coffee—which got its name from the Kaffa province in the south, from where it originally came. Cattle, generally of the small zebu type with a hump between their shoulders, are bred in the highlands. Wild animals used to be very common, but are being wiped out by modern weapons. A few lions are still to be found in the west, and antelopes, packs of monkeys, and birds with most brilliant plumage live in the remoter districts.

Gold is found in the south-west of Abyssinia—in fact it is probable that King Solomon obtained the gold for his temple from the gold-mines of this district. Iron, saltpetre, sulphur, and platinum are also to be found. It is very likely that much more mineral wealth yet remains to be exploited.

Except for Addis Ababa, the capital, Harar, and Diredawa, there are no towns of any size in Abyssinia. Addis Ababa is situated 8,000 feet above sea-level on the southern slopes of the Entoto mountains. It is the centre of trade, as well as the seat of the government, and has a population of about 300,000. The Gebbi, or Imperial Palace, is a rambling collection of buildings, but the Emperor now lives in a modern dwelling. Between the two World Wars many modern government buildings, shops, and offices were built, principally round the large central market-place.

See also Vol. I: Abyssinians.

ADELAIDE. South Australia was founded in 1836 by a company which set out to show how systematic colonization should be carried out. The Surveyor-General, Colonel William Light, himself chose the site of the capital, Adelaide, a few miles inland on the River Torrens, with a range of mountains forming a background to the city. Colonel Light also drew up the plan of the town—and Adelaide is one of the most attractively laid-out towns in the world. The main part of the town is square in plan, with wide streets lined with trees, and it is surrounded by a belt of parklands before the suburbs begin. Adelaide has a good University, and so many fine churches that it is sometimes called 'The City of Churches'. At week-ends and for holidays during the hot summer the people of Adelaide go either up to the mountains or to the sea, only eight miles away.

Adelaide is the centre of a pastoral and agricultural state, and owes its wealth to the land. Unlike those of other states, its early settlers were keenly interested in political theory and self-government, and Adelaide was in 1840 the first Australian city to receive a municipal constitution. The gold-rush of the 1850's passed by South Australia; but in the period following Adelaide grew into a leisurely and dignified city, and has now about 400,000 inhabitants. More recently, a number of industries have been established in the neighbourhood, and have expanded rapidly.

ADRIATIC SEA, *see* Mediterranean Sea.

AEGEAN SEA, *see* Greece.

AFGHANISTAN. This country, roughly the size of France, is composed of mountains (arid since the felling of the forests) and of high plains that are almost deserts. It is bounded on the west by Persia, on the north by the U.S.S.R., on the north and east by the great Himalaya Mountains (q.v.) and the mountainous country of north-western Pakistan which stretches south into the wild country of Baluchistan (see Map, p. 229). Kabul, the capital, lies about [illegible],000 feet above sea-level.

The climate is very dry in summer—the whole country is scorched and frequently swept by dust storms—while in winter a great part of it is under snow. In spring, after the thaw and rains, grass and flowers appear everywhere, and there is grazing for the huge flocks of sheep kept by the nomad herdsmen. But the heat soon burns the mountains dry again, turning their great shoulders and peaks yellow, parchment, pink, and dull copper-green, according to their geological structure, and driving herdsmen into the valleys or watered plains of Pakistan to find pasture. Though the towering range of the Hindu Kush makes a barrier between east and west, the only practicable overland route to India crosses Afghanistan. This fact, together with the wildness of the country and the extremes of climate, has moulded the people and their history (*see* Afghans, Vol. I).

The soil is naturally rich, and where streams and irrigation make cultivation possible, wheat, rice, barley, beans, maize, millet, and tobacco

A VALLEY IN THE HINDU KUSH, AFGHANISTAN
Royal Geographical Society

are grown—and, more recently, cotton and sugar. On the dry lower mountain slopes in the south-west, wild olives and pistachio nuts grow well. Melons, mulberries, grapes, apples, pears, quinces, apricots, plums, cherries, and almonds are the staple food for the peasants during the summer, and some of these fruits are dried in the sun and used to balance the winter diet of mutton, bread, and green tea, varied by savoury rice dishes for those who can afford them. With the completion of large irrigation schemes, made possible by American-built dams forming valley lakes, more land will be cultivated. Nuts and fruit to the value of some £50,000 annually are exported, principally to India. Raw sugar and cotton used to be sent to the U.S.S.R.; but now sugar-refineries and cotton factories are being established in Afghanistan.

There is no railway in Afghanistan; but transport is gradually becoming quicker, as better and more numerous roads are completed, allowing motor-lorries to replace camel caravans. It is, however, largely because of uneconomic transport that the coal in the Bamian district, the oil round Herat, and the iron, copper, and lead in the north are not worked. The Lapis Lazuli (q.v.) mines, famous throughout history, are a government monopoly. So, too, is the most lucrative of Afghan exports, that of Karaculi lambskins, the sale of which has produced as much as one million pounds per year. Until quite recently, many different kinds of money were used by the various tribes in Afghanistan; but as trade with other countries developed, it was found necessary to regularize the Afghan money system, and the National Bank was founded in 1933.

AFRICA. This is the second largest continent, and is about three times the size of Europe. Except for the Nile valley and the Mediterranean coast, Africa was the last continent to be explored by Europeans, being known for long as the 'Dark Continent', a place of mystery, inhabited by savage natives. Settlements had been made in South Africa since the 17th century by the Dutch; but there had been little penetration into the interior of the country because of the dense forests, swampy jungle-covered plains, or uninhabitable deserts which ran right down to the coast. The coasts in places are so unhealthy that they are unsuitable for permanent settlement by Europeans—for instance, the Gold Coast on the west was for long known as the 'White Man's Grave'. During the 18th and early 19th centuries European trade with the Far East was so prosperous that traders—with the exception of those in search of slaves—were not interested in overcoming the difficulties of penetrating Africa.

The great industrial developments in Europe in the 19th century, however, created a demand for new raw materials, such as fats and rubber, and nearly all the European nations took part in the scramble for African territory, where this wealth was to be found. Between 1840 and 1900 Africa was gradually opened up by traders and missionaries, and by explorers who wanted to map the continent and to discover the courses of the great rivers, the NILE and CONGO (qq.v.), Niger, and Zambezi. By 1900 all Africa was mapped and explored, and divided up among Britain, France, Belgium, Germany, Spain, Italy, and Portugal.

Africa lies almost wholly within the tropics, and stretches almost the same distance north and south of the Equator. It can be divided conveniently into four main regions, North Africa, West and Central Africa, East Africa, and South Africa.

In the north-west the ranges of the Atlas Mountains form a high mountainous rectangle jutting into the Mediterranean from which they rise in steep, wooded slopes. Here and there along the coast are small plains backed by terraced fields, principally of oranges, lemons, and vines (*see* MOROCCO, ALGERIA, TUNISIA). Southwards the Atlas Mountains fall more gently to the high plateau of the SAHARA (q.v.) which stretches right across Africa to the Nile valley and reaches the Mediterranean coast in LIBYA (q.v.). It is crossed by several mountain ranges, the most important being the Tibesti range which crosses the heart of the desert from north-west to south-east. There are large areas of sand-dunes in the Sahara, but there are also vast tracts of stone or rock desert. The inhabitants of the desert are nomadic tribes who wander with their flocks in search of pasture, and oasis dwellers who cultivate the fertile land that is found wherever there are wells (*see* SAHARAN PEOPLES, Vol. I). To the south and east of the Sahara there is an area of dry tropical grassland known as the SUDAN (q.v.), which stretches across the continent roughly between latitudes 10° and 15° N. Stock-rearing is important in this district, and gum arabic is collected for export.

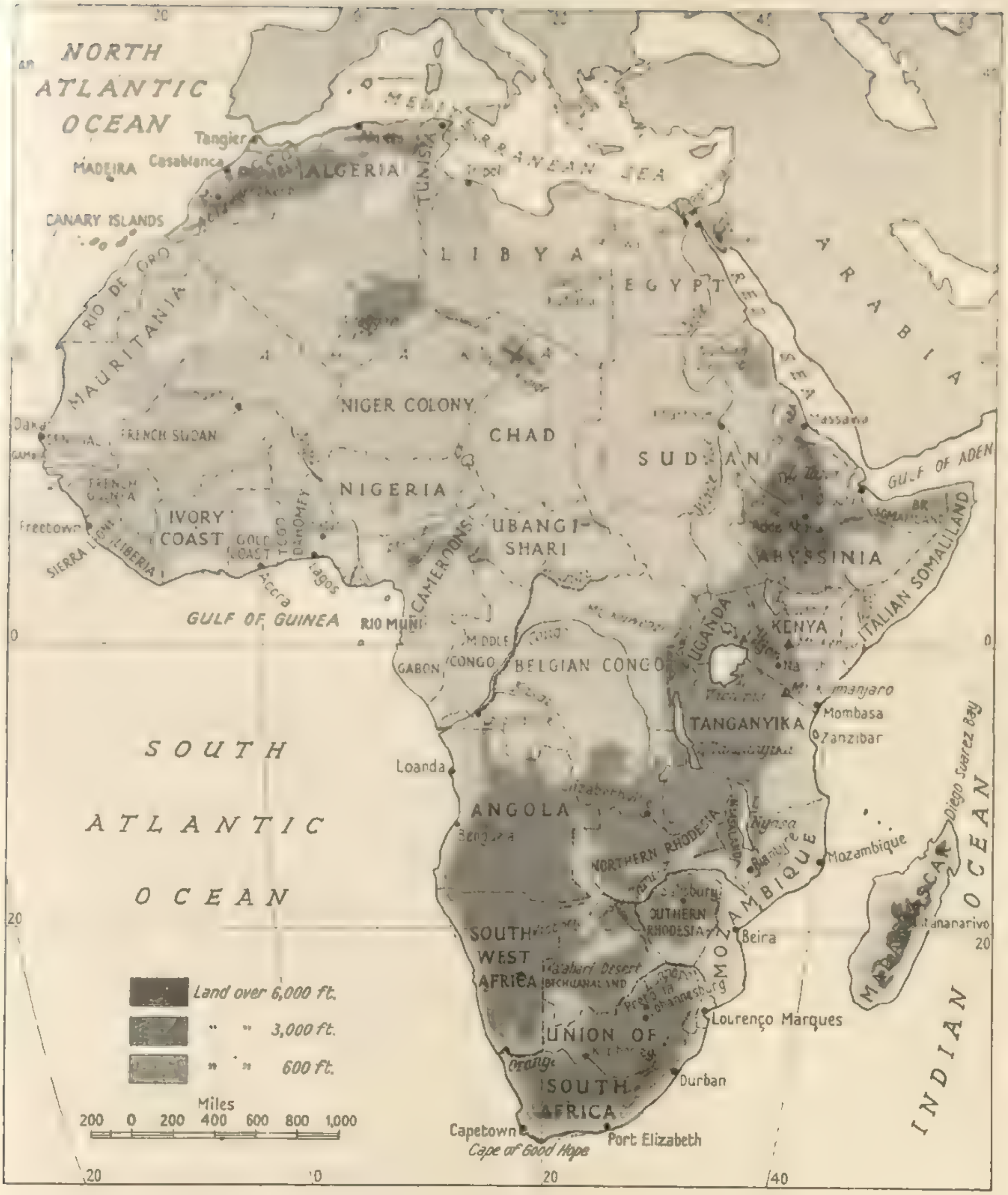
Along the eastern margin is the Nile valley—one of the most fertile areas in the world. The rich soil, spread by the flooding of the Nile, grows rice and cotton and supports a very dense population (*see* EGYPT).

West and Central Africa includes the small states along the Gulf of Guinea from Senegal to Nigeria and French Equatorial Africa (*see* GUINEA LANDS), the BELGIAN CONGO and ANGOLA (qq.v.). Its eastern boundary is the great rift valley with its chain of lakes. It was from the north part of this area that negro slaves were carried off to the plantations of North America in the 17th and 18th centuries (*see* AMERICAN NEGROES, Vol. I). The coastal area and much of the land bordering the Congo River are low, swampy, and covered in dense equatorial jungle. Northwards, eastwards, and southwards the land rises and open woodland is found. The equatorial forests are a valuable source of timber, such as mahogany and teak. Before the days of the rubber plantations in the East Indies they were important as a source of wild rubber. To-day palm-oil, cocoa, cotton, and ivory are exported in large quantities. Cattle and ground-nuts are the chief products of the higher grassland areas.

The third region of Africa is EAST AFRICA (q.v.). It stretches from the Red Sea and the Gulf of Aden south to Nyasaland and west to the rift valley. The whole region is high, except for narrow coastal plains. The independent kingdom of ABYSSINIA (q.v.), which occupies the eastern horn of Africa, is the highest and most rugged area, though the Ruwenzori Mountains of UGANDA (q.v.) and the mountains east of Lake Victoria are very considerable ranges. This is the region of the great lakes of Africa—some of them large enough to be called inland seas. The biggest are Lake Victoria, the long Lake Nyasa, and Lake Tanganyika.

Although the Equator crosses the region, some of the mountains are so high that they are always snow-capped, although their lower slopes may be covered with thick tropical forest and jungle. The high plateaux of south Kenya and Nyasaland are very suitable for European settlement, and the forest has been cleared in large areas for plantations of coffee, tea, and tobacco, mostly grown for export. Cattle-rearing is important in those parts of the plateaux which are free from the TSETSE FLY (q.v. Vol. II). A great deal of cotton is grown in Uganda.

The fourth region of Africa is SOUTH AFRICA (q.v.). It consists of plateaux over 3,000 feet high, surrounded by a very narrow coastal plain. The plateaux are broken in places by flat-topped hills and cut by the eastward-flowing



NORTH ATLANTIC OCEAN
Tangier
Casablanca
MADEIRA
CANARY ISLANDS
ALGERIA
TUNISIA
MEDITERRANEAN SEA
LIBYA
EGYPT
ARABIA
RED SEA
RIO DE ORO
MAURITANIA
NIGER COLONY
CHAD
SUDAN
FRENCH SUDAN
NIGERIA
Freetown
SIERRA LEONE
LIBERIA
IVORY COAST
GOLD COAST
TOGO
DAHOMEY
Accra
Lagos
GULF OF GUINEA
RIO MUNI
CAMEROONS
UBANGI-SHARI
ABYSSINIA
GULF OF ADEN
ITALIAN SOMALILAND
UGANDA
KENYA
MIDDLE CONGO
GABON
BELGIAN CONGO
TANGANYIKA
Mombasa
Zanzibar
SOUTH ATLANTIC OCEAN
Loanda
ANGOLA
NORTHERN RHODESIA
Nyasa
MOZAMBIQUE
Mozambique
Diego Suarez Bay
INDIAN OCEAN
SOUTHERN RHODESIA
Beira
SOUTH WEST AFRICA
Kalahari Desert
BECHUANALAND
Johannesburg
Lourenço Marques
UNION OF SOUTH AFRICA
Orange
Durban
Capetown
Cape of Good Hope
Port Elizabeth
Land over 6,000 ft.
" " 3,000 ft.
" " 600 ft.
Miles
200 0 200 400 600 800 1,000

AFRICA

Zambezi and Limpopo and the westward-flowing Orange River (which, however, is dry in July). The highest plateau, or High Veld, was first settled by the Dutch, who developed cattle and sheep rearing on the dry grassland of the east. Agriculture is hazardous, as there is little rain; but maize is an important crop. In the west is the very dry Kalahari Desert.

Farther south there is more rain, especially near the coast. In Natal and Portuguese East Africa (Mozambique) sugar, tropical fruits, and cattle are the chief products. Mediterranean fruits are grown in Cape Province.

The chief wealth of southern Africa is its minerals. The gold and diamond mines of the Orange Free State and the Transvaal were the first source of wealth, and are still very important. Copper has been developed in Northern Rhodesia (q.v.) and coal in Natal.

See also Vol. I: Negro Africans; South Africans; East Africans; Abyssinians; Egyptians; Saharan Peoples.

AGATE is a form of the variety of quartz called chalcedony. All agate is striped, though not always distinctly: sometimes the bands are straight, sometimes wavy, sometimes zigzag; usually they are parallel to one another; always they are concentric. Agate was usually formed in the steam cavities to be found in the lavas of volcanic rock, and the shape of the bands depends on that of the cavity.

Black and white banded agate is called 'onyx'; brown and white, 'sardonyx'; while red and white is called 'cornelian' or 'carnelian'. Greys, creams, and yellows are also found. Blues and greens are rarer, though these colours are often made artificially by staining and heating the stone. The black and white bands of onyx can be made more vivid by a process in which they are steeped in honey, washed, and then steeped in sulphuric acid, so that the honey is converted to carbon.

The best agates come from Brazil and Uruguay. India and Germany are other sources, and in Scotland agates are found in the lavas of those hills of the midland belt which are volcanic in origin.

See also Minerals; Colour Plate opp. p. 288.

AIR, *see* Atmosphere.

ALABAMA, *see* United States of America.

ALABASTER, *see* Minerals, Section 6.

ALASKA. This extreme north-western peninsula of North America (q.v.) has been United States territory since 1867. In that year it was bought from Russia, which had carried on a precarious but on the whole very profitable fur trade on its mainland and islands for well over a century. So little did the two nations appreciate its value that it changed hands for less than two million pounds. Even then it was long known to the Americans as 'Seward's Folly', after President Lincoln's famous Secretary of State who was responsible for its purchase; but, before the end of the century, the wisdom of his action was doubted by no one. Alaska had become a land of adventure, romance, and riches, which the government could not neglect. In 1884 it was given its first regular government; in 1906 it sent a delegate to Congress, and in 1912 it was represented in the Senate and House of Representatives like the other American states.

The territory of Alaska includes a vast number of islands, the best known of which are the Aleutian Islands (q.v.) and the Alexander Archipelago. Its total area is more than five times that of Great Britain, but whereas Great Britain has a population of some forty-five millions, Alaska has only 73,000. Mountains occupy about two-fifths of its area; there are large stretches of forest, and the climate is too rigorous for agriculture ever to become really important. Its main wealth lies in its fisheries and minerals. The rivers are full of fish—salmon are found in almost unbelievable numbers, and more than half of the salmon production of the United States comes from Alaska. In the surrounding seas herring, cod, and other fish are caught in great quantities. At Juneau, the capital, sardines are packed. The seal industry is still very important, though the yield of the banks has fallen alarmingly owing to bad management in the past. The walrus and the sea otter are nearly extinct, and although whales are still hunted in the Bering Sea, they are much less numerous than they once were, and the profit from their oil has fallen off to such an extent that it is difficult to justify the hazards of hunting (*see* Whaling, Vol. VI).

The chief minerals are still gold and copper, although the Yukon and Nome goldfields appear to be worked out. The fur trade is very important. Alaska has many wild fur-bearing

MOUNT MCKINLEY, THE HIGHEST MOUNTAIN IN NORTH AMERICA, AND THE MULDROW GLACIER

Royal Geographical Society

animals—black bears, grizzly bears, and polar bears; white foxes, blue foxes, and, more rarely, black and silver foxes; ermines, minks, and beavers (*see* FUR HUNTING; FUR FARMING, Vol. VI). Other animals are the grey wolf, from which sledge dogs have been bred, and the reindeer, which was introduced from Siberia to save the Indians from the starvation resulting from the destruction of the wild caribou. These reindeer have increased at such a rate that there is now a surplus to export to the U.S.A.

A large part of Alaska is very beautiful. There are snow-capped peaks, lakes, glaciers, rocky islets, forests, and river scenery of great variety and interest. Many of the highest mountains in North America are there, including Mt. McKinley (20,460 ft.), the highest of them all, and there are active volcanoes. The most important river is the Yukon, which cuts the main peninsula almost in two, but this is free from ice and navigable only for about four months in the year. There are wide variations of climate. In the south it is generally mild and temperate; in the coastal areas of the north within the Arctic Circle the winters are very rigorous indeed. The Bering Sea is almost always covered with cold fog.

The population includes ESKIMOES, AMERICAN INDIANS (qq.v. Vol. I), and white people. Transport facilities have been developed during the present century. Railroads have been constructed, the more important towns are connected by cable and telegraph with western U.S.A., mails are delivered regularly even beyond the Arctic Circle, and a great highway, the Alcan or ALASKAN HIGHWAY (q.v. Vol. IV), over 1,600 miles long, brings the territory into direct communication with the rest of America. The Alaskan Highway is part of a great American highway, rapidly approaching completion, which is designed to connect North, Central, and South America.

ALBANIA. This little republic, which has hardly more than a million inhabitants, lies along the shores of the Adriatic Sea, with Yugoslavia to the north and north-east, and Greece to the south-east and south (*see* Map, p. 160). The country mainly consists of the southern part of the Dinaric Alps, which lie rather farther back from the coast than they do in Yugoslavia. Along the coast is a long plain of flat and rather marshy country, which has a Mediterranean climate, and grows such crops as cereals, grapes, olives, and citrus fruits.

Inland there are rugged mountains and hills, swift-flowing rivers, none of which is navigable, high plateaux, and fertile valleys and plains. The rivers, with one exception, all flow east to west, and are fed by numerous mountain torrents and streams which, during the summer months, are stony tracks, often of considerable width. On the northern and south-eastern frontiers are three big lakes, Lake Scutari in the north and Lakes Okhrid and Prespa in the south. The hills are covered with low oak scrub, and most of the few trees are heavily pollarded for fire-wood. Big forests of beech and oak are found only in the remote mountains, where they have survived because of the difficulty of transporting the timber. The centre of Albania is rich in walnut, sweet chestnut, and almond trees. The winter climate in the mountainous districts, especially in the north, is very cold with much snow. On the coast the winter is fairly short and much less severe. In the summer the temperature is sometimes as high as 110° F. The SIROCCO wind (q.v.), bearing sand dust from

MOUNT POLIS

This harsh mountain scenery is typical of most of Albania.
Royal Geographical Society

the Sahara, often does much harm to crops in the spring and summer, and in the winter the strong 'Bora' north wind is bitterly cold.

Stock-rearing and agriculture are the main occupations. Apart from flour mills and small factories making tobacco, soap, olive-oil, and macaroni, there are no industries in Albania. Almost all manufactured goods are imported. The Albanians export to other Mediterranean countries their agricultural products, including wheat, olive-oil, cheese, tobacco, wool, hides, and horses. In the highlands the people are mainly pastoral. There are many isolated villages, where each family grows in small patches enough for its own needs, and keeps a few animals for meat, milk, wool, and transport. The Albanians breed very strong, sure-footed horses, as well as many donkeys, and the normal way of travelling in country districts is by horse or donkey. There is a railway from Durazzo on the coast to the old capital Tirana. The Romans built a road from the Adriatic to Byzantium which started at Durazzo and ran past Tirana and Monastir in Yugoslavia to Salonika in Greece. During the First and Second World Wars the occupying Italian armies opened up the country with some good roads and bridges, and built embankments in preparation for a new railway line to run from Durazzo to Elbasan in the centre of the country. But much of the country is still inaccessible by anything except mountain paths.

Durazzo, the largest port and former capital, has a very ancient history. Corinthian colonists founded a town on this site in 621 B.C. In Roman times it was a town of far greater importance than it is now, being the starting-point of the important route across the Balkans. It has many ancient ruins to show. Tirana, now the capital, lies about 20 miles inland from Durazzo. One of its most interesting features is a fine old Turkish mosque. Scutari (Skodra) on the south-east of Lake Scutari is a grain-market town, also with an old history and with old customs and superstitions, many of which have survived. Above the town stand the ruins of the citadel which is thought to have been built by the Venetians in the 15th century, during the time when the Venetian Empire extended right down the Adriatic coast (*see* VENICE). There are several small mosques with graceful minarets, and a modern Roman Catholic Cathedral. In the south the port of Valona (Avlona), also a Roman town, has a good natural harbour and a big export trade of wool and oil.

See also Vol. I: ALBANIANS.

ALEUTIAN ISLANDS. Between Alaska in the north of America and the peninsula of Kamchatka in the north of Russia stretch the Aleutian Islands, like a series of giant stepping-stones, extending for a distance of over 1,000 miles (*see* Map, p. 346). Many of the islands are volcanic, and others are the remains of extinct volcanoes. The largest island, Unimak, has two active volcanoes. There are also hot springs on some of the islands.

The sparse population is engaged in fishing, sealing, and fox farming, the centre of the trade being at Unalaska. The importance of the islands, which belong to the U.S.A., lies in their strategic position. In time of war they can be used as air-bases—and were so used against Japan in the Second World War.

See also ALASKA.
See also Vol. VI: FUR HUNTING; FUR FARMING.

ALEXANDRIA, *see* EGYPT.

ALGERIA. Morocco, Tunisia (qq.v.), and Algeria form the Mediterranean part of the great stretch of French North and West Africa (*see* Map, p. 5). Algeria, which is a French possession (whereas Morocco and Tunisia are protectorates), is about ten times as big as Great Britain, and stretches southwards right across the Sahara Desert to the Sudan (q.v.).

Northern Algeria is part of the Atlas Mountains—a complex system of mountain ranges, plateaux, and valleys, which fills the north-west corner of Africa, running roughly parallel to the coast. A line of ranges, called the Tell Atlas, runs along the coast, rising in places steeply from the Mediterranean. In the low ground Mediterranean fruits, tobacco, cereals, early vegetables, and flowers for scent-making are cultivated and exported. On the mountains there is still some forest-land with valuable timber, such as cork oak and holm oak. South of the Tell Atlas runs a stretch of high plateaux, 3,000 to 4,000 feet high, broken by rocky ridges and, towards the east, muddy salt swamps which dry out in summer. Sheep are pastured over the whole area. Farther south runs a second line of Atlas Mountains, called the Saharan Atlas, with high, steep ranges and wide, dry plains. Wherever there are oases, palms and fruit-trees grow.

To the east the coastal mountains, the high plateaux, and the Saharan Atlas join in an area of high, steep mountains, narrow valleys, plateaux, and plains. In the plains and wider valleys many crops are cultivated, and those plains which used to be salt lake beds, and are still marshy in winter and spring, make good grazing ground. On the slopes of the mountains are forests of cedar, cork oak, and Portuguese oak. The south-eastern mountains are still very wild—the ancient refuge and fortress of the Berber people who built their villages on high, easily defendable positions, often only possible to approach by steps or even by ropes. The Berbers cultivate the deep valleys, and pasture their sheep (for most of them are shepherds) for parts of the year in the lands bordering the desert. On the Tunisian border, in the hilly, rather infertile country, are deposits of iron ore and phosphates.

South of the Atlas ranges stretches the great Sahara Desert (q.v.). In the south-east corner of Algeria the desolate high plateau-land of the Ahaggar is the home of the nomad camel-breeding people, the Tuareg (q.v. Vol. I). The camels of the Tuareg tribes can find sufficient scrub and coarse grass on which to live. The craters and cones of old volcanoes rise in fantastic shapes above the dark basalt and granite of the plateaux, which are also cut by deep valleys, in parts well watered enough to grow some vegetables and cereals.

Algeria has several large towns, mostly on the

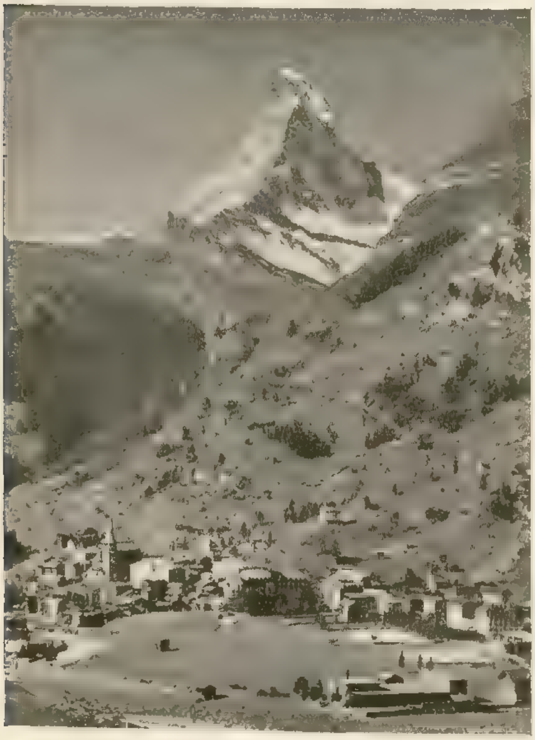
THE WAD EL ARAB WHICH WATERS THE FRUIT-TREES AND PALMS OF AN OASIS
Royal Geographical Society

coast. Algiers, the capital, with a population of over 310,000, is built on a hilly coast in terraces of white-walled houses, climbing 1,000 feet in less than a mile from the quays to the old fortress-palace, the Kasbah. Many of the streets are in flights of steps, sometimes so narrow that three people can barely walk abreast. The harbour, once an Arab pirate base, is now a busy modern port. Oran, with a population of over 250,000, is a commercial city and port, with fine modern business houses and an unmistakably French atmosphere. Constantine, towards the east and some way inland, is more like an Arab city, and has important markets for the local produce; while Biskra, reached now by railway from Constantine, has been for years a centre for the caravan trade.

See also Africa.
See also Vol. I: Arabs.

ALMANAC, *see* Calendar.

ALPS. The Alpine range of mountains stretches in a crescent from the Gulf of Genoa to Vienna, a distance of nearly 600 miles (*see* Map, p. 160).



THE HIGH ICE-CARVED PYRAMID OF THE MATTERHORN RISING STEEPLY ABOVE ZERMATT. *Swiss Federal Railways*

They are part of the young fold mountain system of Europe, to which the Pyrenees (q.v.) to the west and the Carpathians (q.v.) to the east also belong.

The structure of the Alps is complex. During the Mid-Tertiary mountain-building period, perhaps some ten million years ago, a series of earth folds, called 'nappes', were thrown up to form mountains. The earth movements were so intense in places that the nappes lay on top of each other in an intricate pattern. Denudation (q.v.) has since worn away masses of the less resistant rocks, leaving a series of crystalline peaks. The present great height of the Alps is due to a vertical upward earth movement which took place before the Ice Age (q.v.) and allowed the mountain summits to stand above the invading ice sheets.

The Alpine scene, as we now know it, did not take shape until after the Ice Age. The effect of snow and ice produced the sharp outlines and pyramidal shapes of such peaks as the Matterhorn. Glaciers cut out the valleys, blocking up some with debris so that lakes, like the Lake of Zurich in the north and Como in the south, formed behind the barriers. Glaciers (q.v.), such as the Aletsch Glacier, still occupy some of the higher valleys. Layers of sheet ice protected the shoulders of the valleys, and to-day these are the grassy slopes called 'Alpen', which lie in the shadow of the high peaks and provide summer pasture for herds of dairy cows.

Mont Blanc (15,782 feet), the Matterhorn (14,775 feet), and Jungfrau (13,670 feet) lie in the western part of the Alps, and it is chiefly to this region that tourists come to enjoy the mountain scenery and winter sports. Towards the east the Alps lessen in height. In Austria they are known as the Tyrolese Alps.

Above 6,000 feet snow lies for six months in the year, and on the tops of the high peaks all the year round. In winter it is quite warm in the sun and the crisp dry air, but as soon as the sun sets the temperature falls suddenly. The sheltered valleys facing south are well cultivated; but in winter cold air from the mountains fills them, making them colder than the slopes above.

Below the 'Alpen' pastures the valley sides are thickly wooded with conifers, and above the grass zone in sheltered places small hardy Alpine Plants (q.v. Vol. II) are found. The shy little mountain Chamois (q.v. Vol. II) are now much less common than they used to be.

The Alps are crossed by ancient passes which, to-day, carry motor roads and railways. The railways cross the highest part of the range in tunnels, such as the Mont Cenis, $7\frac{1}{2}$ miles long, and the Simplon and St. Gothard, each 12 miles long. Farther to the east the Brenner Pass connects Italy with Austria. In Switzerland Mountain Railways (q.v. Vol. IV) have been built to bring tourists to hotels far up in the mountains, and to carry ski-ers higher still.

In addition to the tourist industry, forestry and dairy-farming occupy the Alpine people. In the southern zone, near the Gulf of Genoa, it is too dry to grow pasture for cows, so sheep are reared. Some of the mountain lakes, Lake Grimsel in the Bernese Alps, for instance, have been dammed to provide water for generating electricity which is used in the factories of Switzerland and north Italy.

See also Switzerland; Mountain Building.

ALSACE-LORRAINE, *see* France.

AMAZON RIVER. This South American river, the greatest river in the world, measures over 4,000 miles from the source of its main headstream, high up in the Andes, to its mouths on the east coast of Brazil. It has a larger volume of water than any other river in the world, and the Atlantic Ocean for many miles off the coast of Brazil is stained muddy red by the silt it carries. Yet the effect of ocean tides is felt 400 miles up the river. The Amazon is known by different names at different stages of its upper course, and is not called Amazon till it reaches the Brazilian river-port of Manaos, some 1,600 miles from the sea. Many of its tributaries are larger than any river in Europe.

After leaving the gorges and waterfalls of the Andes, the Amazon enters the vast lowland of the Amazon Basin. This lowland stretches eastwards from Peru across Brazil to the Atlantic Ocean, between the Guiana Highlands in the north and the Matto Grosso Plateau in the south. It is forested with a dense growth of trees, shrubs, creepers, and climbing tropical-forest plants of many varieties. So dense is the vegetation that sunlight rarely penetrates to the twisted, coiled plant-growth of the forest floor. There are very few tracks, and the river and its tributaries, with the innumerable streams and creeks which branch from them, are the only highways. Very few people live in this dense forest, and these are mostly a primitive type of Indian (*see* American Indians, Central and South, Vol. I).

THE UPPER AMAZON BORDERED BY DENSE EQUATORIAL FORESTS. *Royal Geographical Society*

The Amazon Basin is in the tropics, and consequently the river and its tributaries are fed by torrential rains at certain seasons of the year, as well as by melting snow-water from the Andes. There is usually a difference in height of about 50 feet between the river-levels in the dry and wet seasons; and in the wet season widespread flooding is usual. The flooded area is often about 200 miles wide, and the river then looks like an inland sea. Even in the dry season the lower Amazon is like a branch of the ocean, for ocean steamers go right up to Manaos, and smaller ships can even get as far as Peru. The Amazon reaches the Atlantic through a vast delta, with many islands and numerous streams and channels.

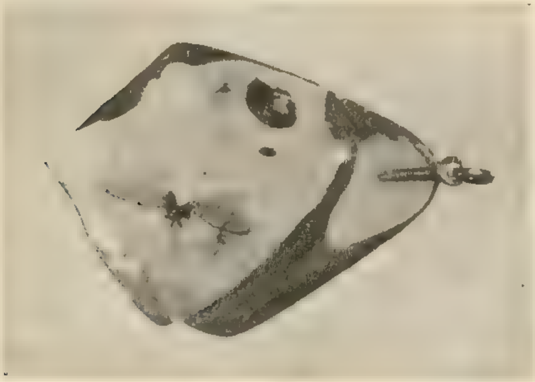
The forests of the Amazon Basin hold a great wealth of timber, fruit, nuts, herbs, and medicinal plants—all almost completely unexploited.

In the forests live jaguars, sloths, tapirs, reptiles, snakes, monkeys, a great variety of water-birds, humming-birds, and parrots, and a multitude of brilliantly coloured butterflies and insects. The hot, steamy climate, difficult for a white man to endure, has prevented further exploitation of its riches.

See also RIVERS; SOUTH AMERICA.
See also Vol. II: BUTTERFLIES AND MOTHS (TROPICAL); TROPICAL JUNGLES.

AMBER. Amber is not a mineral, but a fossilized resin or gum. It was formed millions of years ago in the Oligocene Age when certain types of coniferous trees grew in abundance, died, and were buried in the earth. The land sank under the sea, and in the blue clay which formed, amber is found—sometimes with flies or other insects embedded in it. It is light in weight, warm to the touch, and, unlike resin, does not become sticky when rubbed. The colour of amber ranges from white to darkish brown, and there are also reds and bluish and greenish tints. It may be transparent or cloudy.

From earliest times amber has been used for necklaces and amulets, and there are many superstitions and legends connected with it. Some of these undoubtedly owe their origin to its power, when rubbed, of attracting small pieces of paper. The ancient Greeks called it *elektron*, and it is from this that we get our own word electricity. In addition to its use as a charm, amber was once thought valuable as a medicine. Worn as a necklace it was supposed to cure ague and prevent goitre; ground up into a paste with honey a dose would help deafness or a salve improve the eyesight! The early Chinese burned it as incense.



A FLY IN AMBER

Some of the earliest-known roads in the world are those by which amber from the Baltic was taken overland to the more civilized people of the Mediterranean. These are dated as early as 2000 B.C. in the Early Bronze Age, and much earlier than this the Baltic peoples of the New Stone Age were using it in quantity and burying it in their graves. To-day the most important source of amber is still the Baltic coastlands of Germany and the U.S.S.R., though small supplies come from Sicily, southern England, Roumania, and Burma.

As amber is brittle and breaks easily, great care has to be taken in working it; but when carved and polished it is very effective and has for long been used for jewellery and delicately carved ornaments.

See also ELECTRICITY.
See also Vol. I: PREHISTORIC MAN, Section 5.

AMERICA, *see* UNITED STATES OF AMERICA; NORTH AMERICA; SOUTH AMERICA.

AMETHYST. Many superstitions are connected with this stone. Roman women believed that by wearing it they would keep the love of their husbands, and the Greeks believed that if they drank from goblets made of it they would not become intoxicated. In the Middle Ages it was reckoned to bring good fortune to its wearer.

Amethyst is a form of quartz, transparent and ranging in colour from pale violet to deep reddish-purple. Deep-coloured flawless stones are expensive, though all become greyish in artificial light. Amethysts are found in igneous rocks. Brazil and Uruguay are the chief sources of supply, though some come from Ceylon, Mexico, the U.S.S.R., and Burma.

See also MINERALS; ROCKS, Section 2.

AMSTERDAM. Though situated on an inland sea, the Zuider Zee, Amsterdam is one of the world's great ports and the commercial capital of Holland. (The administrative capital is The Hague.) Amsterdam is built on the south bank of the River Amstel, a small river flowing into the Zuider Zee, but it is connected by canals to its outport of Ijmuiden on the North Sea, and to the RHINE (q.v.).

Amsterdam began to be important in the 13th century as a meeting-place of continental routes. Despite many and sometimes successful attacks,

A CANAL IN AMSTERDAM
K.L.M.

it grew in wealth and strength, till in the 17th century it had the largest merchant fleet in Europe. During the domination of Napoleon it lost its wealth; but as soon as French rule ceased commerce revived, and the trades for which the town is famous to-day—tobacco, coffee, tea, spices, tin—became established. Modern industries include sugar-refining, distilling, motor-car and aeroplane manufacture, and diamond-cutting, for which it is the principal world centre. Shipping is still very important.

Much of Amsterdam's internal transport is by water. Many of the canals are muddy and sluggish, but the elm-trees and elegant 17th-century mansions built by the wealthy merchant princes give them a dignified, impressive beauty. Amsterdam grew round the Dam, her most important square. In the Dam are the Royal Palace and the New Church (in fact, this is one of Amsterdam's oldest churches), and also some fine modern buildings. To the east of the Dam is the foreign quarter, which has a large Jewish population, and is where REMBRANDT (q.v. Vol. V) lived. Among the maze of canals the Kalverstraat, the busiest shopping street in the city, runs its entire length without sighting water. The outskirts of Amsterdam have been carefully planned, and the modern blocks of flats for working-class families are some of the best in the world.

See also HOLLAND; THE HAGUE.
See also Vol. I: DUTCH.

ANDAMAN ISLANDS, *see* INDIAN OCEAN ISLANDS; *see also* ANDAMAN ISLANDERS, Vol. I.

ANDES MOUNTAINS, *see* SOUTH AMERICA.

ANDORRA, *see* SPAIN; PYRENEES.

ANGLO-EGYPTIAN SUDAN, *see* SUDAN.

ANGOLA. Portuguese West Africa, or Angola, has been under Portuguese influence ever since Diogo Cão, the Portuguese explorer, landed on the coast near Lobito Bay in 1482, except for the period 1641–8 during which the Dutch were in control.

Almost all Angola lies south of the River Congo, west of Rhodesia, and north of southwest Africa; but there is a small disconnected territory, called Kabinda, on the coast to the north of the Congo mouth. Along the coast runs a narrow plain, dry and infertile in the south, but growing tropical crops such as oil-palms, rubber, sugar, cotton, and rice in the north. Terraced hills rise steeply above the plain to a plateau of grassland and woodland. The lower hill-slopes are forested, except where they have been cleared for palm, coffee, and cocoa plantations. On the grasslands of the plateau the negro natives rear cattle and grow tobacco and citrus fruits.

Fishing is an important industry, diamonds are mined, and there are copper and gold reserves still unexploited. Angola has not been developed very fully because much of the country, especially the fertile coastal area in the north, has a tropical and malaria-infested climate unsuitable for European settlement.

See also AFRICA; CONGO RIVER.
See also Vol. I: NEGRO AFRICANS.

ANKARA, *see* TURKEY.

ANNAM, *see* INDO-CHINA.

ANTARCTIC OCEAN, *see* OCEANS; POLAR REGIONS; POLAR REGIONS (EXPLORATION).

THE ALLEGHENY MOUNTAINS OF VIRGINIA, PART OF THE APPALACHIAN RANGES. *Royal Geographical Soci*

ANTICYCLONE, *see* WEATHER.

APENNINES, *see* ITALY.

APPALACHIAN MOUNTAINS. These ranges of mountains stretch along the east of North America from Newfoundland and Canada to central Alabama in the U.S.A. The northern section, from Newfoundland to the Hudson River, is formed by the White Mountains of New Hampshire and the Green Mountains of Vermont. The central section, from the Hudson River to New River in Virginia, contains the Alleghenies and the broad valley known as the Great Appalachian Valley. The southern section runs south from New River, and its chief ranges are the Blue Ridges, which continue from the central region, and the Black and Smokey Mountains. The Appalachians are much older than the ROCKIES (q.v.) and much worn down by erosion. Their slopes are gentler, their summits more rounded, and their rivers are not so swift. There are no very sharp peaks, no dominating heights—none reaching the region of perpetual snow.

The Appalachians form a natural barrier between the coastal states of the east and the central or middle-west region; and the roughness of the passes, the multiplicity of the ridges, and the thick forests were for long serious obstacles to the westward advance of British and American colonists. The only easy routes were through the Hudson and the Mohawk valleys and at the southern end of the range—and these were closely guarded by hostile Indians, French, or Spaniards. In the 18th century the French planned a great line of military forts from the mouth of the ST. LAWRENCE to the GREAT LAKES, down the Ohio Valley to the MISSISSIPPI (qq.v.), and thence to its mouth in the Gulf of Mexico, so that they might hold all North America west of the Appalachians. Wolfe's victory over the French at Quebec, however, frustrated the plan, and Scottish Highlanders as well as colonists crossed the Alleghenies.

The Appalachian region contains more than one-third of the population of the United States. Much of the land is forest, yielding quantities of valuable timber—pine, cedar, spruce, birch, ash, and maple—particularly in the Canadian and New England sections. Much of this land is too hilly for cultivation; but farming and dairy-farming are carried on in the valleys. The main source of wealth, however, is industry. There are enormous supplies of coal, especially in the Pennsylvanian coal-field, the biggest coal-field in the world. There is a wide variety of textile industries, and very important iron and steel works, especially in Pittsburgh and Homestead. The Appalachian rivers—the Hudson with its tributary the Mohawk, the Delaware, the Susquehanna, the Potomac, and the tributaries which feed the mighty Ohio—are used to produce water-power.

There are many holiday resorts in the Appalachian Mountains, popular because of the

grandeur and variety of the forests, the lovely mountain streams, and the thickets of rhododendron and other flowering shrubs. In some of the more remote parts there are still wild animals, such as the puma or mountain lion, bears, wildcats, and wolves; and in the Canadian north there are large numbers of foxes, deer in some parts, and moose.

See also NORTH AMERICA; UNITED STATES OF AMERICA.

AQUAMARINE. This is a variety of beryl of the same chemical composition as EMERALD (q.v.). It is found in large, generally almost flawless, crystals, and is cheaper than emerald, though the deep-bluish stones are expensive. Yellow aquamarine is known as 'golden beryl' and the pink variety is called 'morganite'.

Aquamarine occurs in cavities in granite in the Urals, in Ceylon, in Brazil, and in Colorado and California in the U.S.A.

Morganites are the largest pink gem-stones known, and are found in Madagascar, Ceylon, and the U.S.A.

ARABIA. The north-west corner of Arabia is the southern land-link between Europe and Asia. Arabia is a great peninsula formed by a tilted plateau of old hard rock, rising steeply above the Red Sea and sloping east to the Persian Gulf. It consists of the large kingdom of Saudi Arabia, and small independent Arab states, such as Yemen, Oman, and Hadhramaut in the south. Between 1913 and 1926 the great Arab leader King Ibn Saud gradually built up the united kingdom of Saudi Arabia, which now consists of almost the whole peninsula.

The interior of Arabia is barren desert, and much of it was unknown to the world until the recent activities of the Anti-Locust Mission (*see* LOCUSTS, Vol. VI). The Arabs who live there are called BEDOUIN (q.v. Vol. I) or desert-dwellers. They dwell in strange black tents, and rear camels, asses, horses, and goats. The only settlements of any size are in the central oasis of Shammar, which separates the Nefud Desert in the north from the Rub-al-Khali Desert in the south. Hail and Riyadh, the capital of Saudi Arabia, are typical Arab towns, with flat-roofed houses made of mud, daubed white. The caravan route from the Persian Gulf to Mecca runs through Riyadh.

The coastal regions of Arabia are better watered because the mountains bring rain which fills the *wadis* (seasonal watercourses), and so crops can be grown. The most important port on the west coast is Jedda (or Jidda), a picturesque town of tall, narrow, stone houses, with windows and shutters of Javanese teak. There is much decorative work on the house fronts, ideas for which have come from trading contacts with Malaya and the Far East. A motor road runs 50 miles inland from Jedda to Mecca, one of Arabia's oldest cities and the goal of the Moslem pilgrim (*see* ISLAM, Vol. I). Mecca stands in a wadi, and the flat-roofed houses climbing up the barren hill-sides are often many

CAMELS GRAZING NEAR JUNAINA OASIS, SAUDI ARABIA
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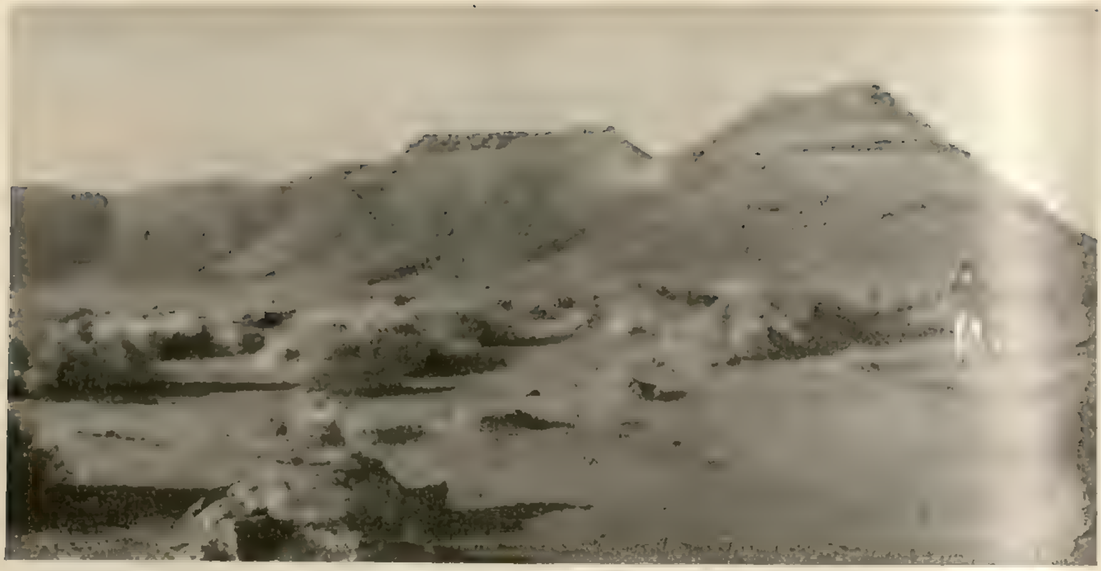


THE CENTRAL ARABIAN DESERT. *Royal Geographical Society*

storeys high. The streets, though wide, are dirty, and the city is full of lodging-house keepers and guides. A large part of the population is made up of pilgrims who come from all over the world to visit the birthplace of MOHAMMED (q.v. Vol. V). The principal feature of this Holy City is the Great Mosque. It has a large quadrangle surrounded by cloisters with decorated arches, and in the centre stands the shrine. Mecca had a sacred shrine and was a centre of pagan worship for centuries before Mohammed founded the faith of Islam. Medina, lying farther north, the burial-place of Mohammed, is another Holy City and centre of pilgrimage.

The most fertile part of Arabia is Yemen in the south-west. Much of it is very dry, owing to the hot SIROCCO (q.v.) that blows from Africa; but the summer monsoon brings rain to the south-west. The famous Mocha coffee is cultivated there and exported from the port of Hodeida. The coffee is grown on the hill-sides, and the mists that rise from the valleys protect the plants from the sun. Millet and dates are grown for food, and there is rough grazing for camels and goats on the *casab* (coarse grass). When the wadis fill after the rains the peasants try to deflect the water to their crops, and this causes many disputes. Water is usually drawn up from the river by camels, and brought to the fields in goatskins. The *Imam*, or ruler, of Yemen lives in Sana, a walled city with eight gateways. There are several Jewish settlements, with many skilful craftsmen.

The Bab-el-Mandeb Straits, which connect the Red Sea to the Indian Ocean, are guarded by the British outpost of Aden, a port of call and an oiling-station, where Arab dhows and British warships lie side by side.

East of the Straits, along the south-west of Arabia, there is the little-known region of Hadhramaut, the only place in the world (except Somaliland) where frankincense and myrrh are obtained. The export of incense is a very ancient trade: the route of the old frankincense road can be traced by the ruins of former cities. In the better-watered areas date-palms flourish, and indigo, tobacco, and cereals are grown in the wadis. The region is ruled by the Sultan of Mukalla, which is the chief town and port.

Farther east, stretching round the south-east corner of Arabia, lies the mountainous region of Oman, with its chief town and port of Muscat, from which the famous Muscat dates are exported. Many of the people are negroes, because at one time the African island of Zanzibar was under the rule of the Sultan of Oman.

In the Persian Gulf, east of Arabia, are the Bahrain Islands, centre of PEARL-FISHING (q.v. Vol. VI). Because of the great value of the fisheries the sheikhs of the neighbouring regions

SOUTH-WEST ASIA

made a truce against piracy; and that is why the stretch of coast is known as the Trucial Coast. The Bahrain Islands are a British possession, but are ruled by the Emir of Bahrain, who lives in Manama, a town now being rebuilt on European lines. The Arabs dive for the oysters from flat-bottomed boats, and the trade in pearls is carefully controlled. The other centre of the pearl-fisheries is Kuwait, a port lying at the head of the Persian Gulf.

The spectacular development of oil production (*see* OIL, MINERAL, Vol. VII) in the Dhahran area of Saudi Arabia, in the Sheikhdom of Kuwait, and in the Bahrain Islands, is changing the economy and pattern of life of the ARABS (q.v. Vol. I) in these areas.

ARCHANGEL (Arkhangelsk). This Russian town was founded in the 10th century on the east coast of the White Sea, at the mouth of the River North Dvina. It remained but a small fishing-port until the 16th century, when, after the visit to the court of the Tsars of an English traveller, Chancellor, it was developed as an exporting port for flax, timber, and furs—for at that time Russia had no Baltic port. The timber and furs came from the surrounding district, the flax from the Volga lands. In the last 20 years the population of Archangel has more than trebled itself, for the exploiting of the vast timber resources of the north-west of the U.S.S.R. and the working of its mineral wealth have resulted in the gathering of skilled workers there from the surrounding district (*see* R.S.F.S.R.).

To-day Archangel is second only to Leningrad in the timber it exports—though during the winter months, when the White Sea and the Gulf of Finland are frozen, both ports are superseded by Murmansk. The timber is floated down the North Dvina and its tributaries, and stacked in huge piles along the river-banks.

Canals connect the Volga water-ways with the North Dvina, and wheat and flax for the city's flour-mills and linen factories are brought by water as well as by rail. Coal is brought from the Pechora fields in the east to provide fuel for the saw-mills, pulp- and paper-mills, chemical industries, shipbuilding, and tanning. The curing and canning of fish is also an important industry.

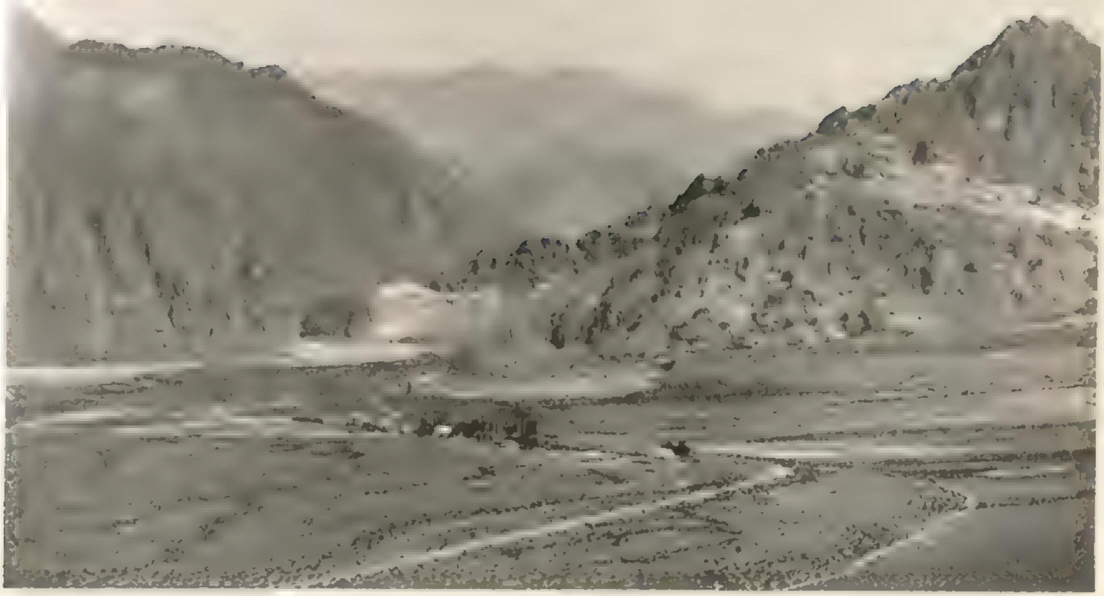
ARCTIC OCEAN, *see* OCEANS; POLAR REGIONS; POLAR REGIONS (EXPLORATION).

ARGENTINA (the Silver State). The Argentine Republic is the south-eastern part of South America, and lies between the Atlantic Ocean and the Andes. When the Spaniards first came to the east coast of Argentina in the 16th century and sailed up the River Plate estuary, they believed that they would find silver; so they called the estuary Rio de la Plata (River of the Plate), which means River of Silver. In fact, there was no silver, and the real La Plata is not a river but an estuary, into which the rivers Paraná and Uruguay flow from the north. Nevertheless, the name stuck, and was perpetuated in 'Argentina', from the Latin word *argentum*, silver. Argentina is the second-largest country of South America: it is five times the size of France, and has a population of over 17 million people. It is roughly triangular in shape, and stretches from about 20° S. to 55° S.—that is, from the Tropics to the Antarctic. Chile and Russia are the only other countries in the world with so great a range of territory, from north to south (*see* Map, p. 415).

Argentina falls naturally into four parts. The Andes run the whole length of its western side. In the north there is the wooded, swampy, tropical region known as the Chaco. In the centre are the pampas, once a sea-bed, but now a vast prairie stretching from the Atlantic to the Andes. In the south, Patagonia, a dry and barren plateau, stretches to the Magellan Straits. Argentina divides with Chile the Island of Tierra del Fuego, lying beyond the Magellan Straits at the tip of the continent. This is for the most part a wind-swept wilderness of black lava, thorns, and pebbles.

The volcanic mountains of the Andes stretch the whole length of Argentina. In the north they enclose the bleak desert plateau of Atacama, parts of which also belong to Chile and Bolivia. It is a rich source of copper and borax. Farther south beautiful wooded slopes rise above rich valleys, where vineyards and orchards flourish. The highest peaks of the Andes are in Argentina, the highest of all being the mighty snow-clad summit of Aconcagua, 22,850 feet above sea-level.

The Chaco is a wet, swampy plain, rich in timber and with a great variety of birds, insects, and animals. In the forests of the Chaco is found a valuable tree with wood so hard that the Spaniards called it *Quebracho*, which means 'axe-breaker'. The wood is so heavy that it will not float, and it is very valuable for railway-sleepers,



THE MENDOZA VALLEY IN THE ANDES THROUGH WHICH THE BUENOS AIRES–VALPARAISO RAILWAY RUNS

Royal Geographical Society

paving-blocks, and the piles on which bridges are built. A juice called tannin is extracted from it, and is used for tanning hides. In the southern Chaco cotton, sugar, and tobacco are grown.

Westwards from the Atlantic to the Andes stretch the pampas—broad, undulating plains broken by scarcely a tree. Their mild climate makes them one of the most fertile regions of the earth, capable of supporting enormous flocks and herds on their rich grasses or, when ploughed up, of becoming perhaps the world's richest grain land. The characteristic vegetation used to be the tall 'pampas grass', with coarse leaves and feathery spikes, sometimes growing to a height of 8 or 9 feet. But in cattle-rearing areas this has given way to the bright emerald-green alfalfa or lucerne (a plant similar to clover), which was introduced by Europeans. The alfalfa has made possible a great expansion of the cattle industry, for it is said that where the land used to graze 500 cattle it now can support 2,000. Many other plants and trees, such as the sycamore and the acacia from Europe and the eucalyptus from Australia, have been introduced into the pampas and have thriven there. The pampas have supported, in succession, a great sheep industry, a great cattle industry, and a great wheat industry; but the rise of one has not meant that the others have died out. With the coming of cereals the herds have been driven farther inland. Wheat and meat together are sources of the wealth of Argentina, and both are exported in vast quantities (*see also* GRASSLANDS).

The plateau of Patagonia, in the south of Argentina, has been little developed, though sheep-farming is carried on in some of its sheltered valleys.

Argentina has neither coal nor iron of her own, and so far petroleum has not been found in any quantity. Her main industries are all connected with the land—flour-milling, sugar-refining, meat refrigeration and canning, wine-making, and tannin-extracting being the most important. BUENOS AIRES (q.v.), the largest city in South America, is the capital. Rosario, up the Parana River, is the second city and a great grain port. Bahia Blanca, a naval port, Cordoba, a very ancient city with a very old university, and Tucuman in the sugar country of the north, each has over 100,000 inhabitants.

See also Vol. I: ARGENTINES.

ARKANSAS, *see* UNITED STATES OF AMERICA.

AN ARMENIAN CHURCH
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ARMENIA. The Soviet Socialist Republic of Armenia, together with the Soviet Socialist Republics of AZERBAIJAN and GEORGIA (qq.v.), forms Transcaucasia. Georgia lies north of Armenia, Azerbaijan lies east, to the south is Persia, and to the west Turkey (*see* Map, p. 75).

Armenia is a highland region of mountains, the Armenian Highlands or Little Caucasus, which enclose high plateau-basins. In the highest of these basins is Lake Sevan, an enormous lake greater in area than all the Swiss Lakes together. It is estimated to be over 300 feet deep. The Armenian Highlands are volcanic in origin, and many of the huge rocks and boulders which litter the countryside are red, grey, and black. The mountain summits are snow-covered for 10 months of the year, and the slopes are wooded or grassy, suitable for pasture. In the valleys, and especially in the valley of the River Arax, there is intensive cultivation of cotton, fruit-trees, grain, and vines.

Copper, zinc, pyrites, and iron are mined, and at Erivan, the capital, there are chemical works, a big hydro-electric station, cotton-mills, fruit canneries, and a synthetic rubber plant.

See also R.S.F.S.R.
See Vol. I: ARMENIANS.

ARTESIAN WELL, *see* WELLS AND SPRINGS.

ASBESTOS, *see* MINERALS, Section 3; ASBESTOS INDUSTRY, Vol. VII.

ASIA. This is the largest continent, occupying one-third of the land surface of the world, about 17 million square miles. It is surrounded by sea on the north, east, and south; on the west it is separated from Europe by the Ural Mountains and the Caspian Sea and is joined to Africa by the narrow Isthmus of Suez. The continent stretches from the Arctic Circle to south of the Equator. There are great plains, high, steep mountain barriers, vast plateaux, and hundreds of islands, ranging in size from Borneo, which is about the size of Germany, to mere rocks. Asia has altogether 1,155 million people, much more than any other continent.

Eastern Asia was not really known to the Europeans until the 15th century, although very advanced civilizations, quite as old as those in Europe, had developed in India and in China. Early expeditions, especially those of ALEXANDER THE GREAT, had penetrated as far as India, and had brought back rumours of its lands and people. But in 1275 the famous journey of MARCO POLO (qq.v. Vol. V) to Peking in China took place. He wrote a graphic account of his travels, which was published in the early 15th century, and his stories of gold and riches stimulated others to explore the east.

A significant characteristic of Asia is that by far the greater part is high land. There are vast stretches of plain—in the north-west of Asiatic U.S.S.R., in eastern Arabia, the great river plains of the Indus and Ganges in India, of the Yellow River and Yangtze-Kiang in China, of the Mekong in Indo-China, and the flat swampy coastal plains of Sumatra and Borneo. But though these are important as being the most densely populated areas of Asia, they are small in extent compared with the whole. From the Caucasus and Turkey high ranges sweep through Persia and Afghanistan to the mass of mighty mountain peaks, the Pamir Mountains, which lie on the borders of north-west India, south Russia, and south-west China. To the east there opens out a great triangular area of very high mountain ranges separated by lofty barren plateaux. The highest ranges are those of the Himalayas, the loftiest mountains in the world. Tibet is the highest plateau in the world, and the vast Gobi Desert of Mongolia the most barren. The mountain ranges are continued in

ASIA

Larger scale maps of sections of Asia will be found in other articles: 1. ARABIA (p. 17), 2. INDIA (p. 229), 3. CHINA (p. 17), 4. EAST INDIES (p. 144), 5. U.S.S.R. (p. 459)

the islands of the East Indies and Japan. South of this highland triangle are two great plateaux, one forming most of Arabia, the other southern India.

In the Asiatic plains of the U.S.S.R. winters are bitterly cold and summers very warm and dry. There are great stretches of coniferous forests (taiga), except in the extreme north, where the frozen ground supports only mosses and lichens (tundra), and in the area east of the Caspian Sea, where pasture land and grain-farming are very important.

The mountain ranges of central Asia are usually forested on their lower slopes, and many of their valleys are intensively cultivated. Most of the plateaux are barren and infertile, some are deserts, and others are poor grassland broken by salt lakes. All of them have insufficient rainfall and very cold winters.

The southern peninsulas of India, Burma, Malaya, Siam, Indo-China, south China, and the East Indies are much more favoured lands. They have a rich natural vegetation and a productive climate. There are still vast swamps and thousands of miles of deep jungle, but most of the lowlands and the adjacent mountain-sides are intensively cultivated. A large proportion of Asia's enormous population lives in these regions —in fact the population is so dense that, in spite of the richness of the land, the general standard

of living is low. Rice is the staple food of southern Asia, and paddy-fields are a very common sight. Wheat, maize, spices, and cotton are grown, and there are extensive European plantations of tea, coffee, rubber, sisal, oil-palm, and coco-nut palm.

In all these densely peopled countries of south-east Asia there are large cities of ancient splendour and importance, and in Japan, India, and China great modern industrial cities have grown rapidly. But Asia is still primarily agricultural: industrial development is only just beginning. There are large deposits of coal, iron, tin, and oil already known, and there are probably much larger and richer deposits yet to be discovered. However, in view of the millions of peasant farmers, it seems unlikely that industry will ever take the place of agriculture as the main occupation of the peoples of Asia.

ASIA MINOR, *see* Turkey.

ASPHALT is familiar to most people as the brownish-black material which is used, either in cake or powder form, by the application of heat

LOADING TRUCKS WITH ASPHALT ON THE PITCH LAKE, TRINIDAD. *Paul Popper*

for surfacing roads, especially in towns [illegible]re is little at first to connect it with the [illegible]ol which drives the cars using those same [illegible]s. Yet asphalt and petrol are both derivat[illegible] of 'bitumen', a substance formed by natu[illegible]m the remains of microscopic creatures and [illegible]ts which were alive millions of years ago [illegible]as Coal (q.v.) was formed from trees an[illegible]s. The process of transformation is mo[illegible]ly described in the article Oil, Natura[illegible]e petroleum is one form of bitumen.

The particular usefulness of asphalt lie[illegible]he fact that it is absolutely waterproof, always remains slightly elastic, and, when heated, will stick to almost any dry and non-dusty surface. It is one of the oldest building materials in the world. The 'slime' which, the Bible tells us, was used as mortar in building the Tower of Babel was almost certainly asphalt, and the ruins of Nineveh and Babylon show to this day that it was similarly employed by the Assyrians and Babylonians. The ancient Egyptians imported asphalt from Judaea and Sicily and used it for 'mummifying' or embalming their dead, and the earliest boats to row or sail on the Mediterranean were caulked with the same material.

Asphalt occurs in many parts of the world and in rocks of every geological age. As it may result from the drying up of petroleum, it is almost always present in oil-bearing regions. But it also occurs in beds as a rock, and is common in this form near Babylon and the Dead Sea, in parts of France, Switzerland, Dalmatia, and Hanover, in the West Indies, and in Venezuela. The famous Pitch Lake of Trinidad was visited by Sir Walter Raleigh (*see* West Indies). It covers almost 100 acres, and in places the surface is firm enough to support a team of horses. Its depth is not known, but as soon as a hole is excavated it commences to fill in slowly from below with plastic material which becomes harder on exposure to the air. Bubbles of gas are continually given off. The asphalt lake in Venezuela (q.v.) is said to exceed 1,000 acres and is the largest known. Cuba also has rich supplies of asphalt. The rock of the Val-de-Travers in Switzerland, at Seyssel in eastern France, and at Limmer, near Hanover, is a bituminous Limestone (q.v.) containing from 7 to 20% of asphalt.

In addition to its employment for road-surfacing, asphalt is very widely employed in the building industry to-day for waterproofing

in many forms, from damp-courses to roofing-felts, and as a shock-absorbing material for foundations.

ASTEROIDS, *see* Planets, Section 6.

ASTROLOGY, *see* Vol. I.

ASTRONOMY, HISTORY OF. Astronomy claims to be the oldest of the sciences, because men have studied the movements of the stars and planets since long before the start of written history. Certainly in the ancient civilizations of the Chinese, Babylonians, and Egyptians (qq.v. Vol. I) much time was spent in studying the heavenly bodies, and much was known about them of value to astronomy. For instance, the fixed stars had already been arranged into Constellations (q.v.) and the movements of the planets been noted. In China as early as 2300 B.C. eclipses of the Sun could be successfully predicted and, little later, the length of the year was fixed at 365¼ days. Not much later the Babylonian priests were keeping elaborate astronomical tables, the length of the year was known, and the day had been divided into 24 hours. The Egyptians are said to have observed the month (or 'moon-th') of 30 days as early as 4000 B.C., and it was probably they who first used the year as a standard measurement—of particular significance to them because of the annual flooding of the Nile, on which their agriculture depended.

The oldest document we have of the constellations is that of Eudoxus (409–356 B.C.), who seems to have established an 'observatory' and to have conceived a system of movable but interlocking spheres with the Earth as the centre to account for the motion of the Sun, Moon, and planets.

Pythagoras (*c.* 582–500 B.C.) held that the Earth is spherical and that, together with the Sun, the Moon, the planets, and the stars, it revolves round a 'central fire'. Heraclides (388–315 B.C.), a pupil of Plato, went farther and held that the Earth rotates on an axis in 24 hours and that Mercury and Venus make orbits round the Sun.

Aristarchus of Samos (310–230 B.C.) decided that the Earth, as well as the planets, revolves round the Sun (the 'heliocentric system'), and he made attempts, partly successful, to measure the size and distance of the Sun and Moon.

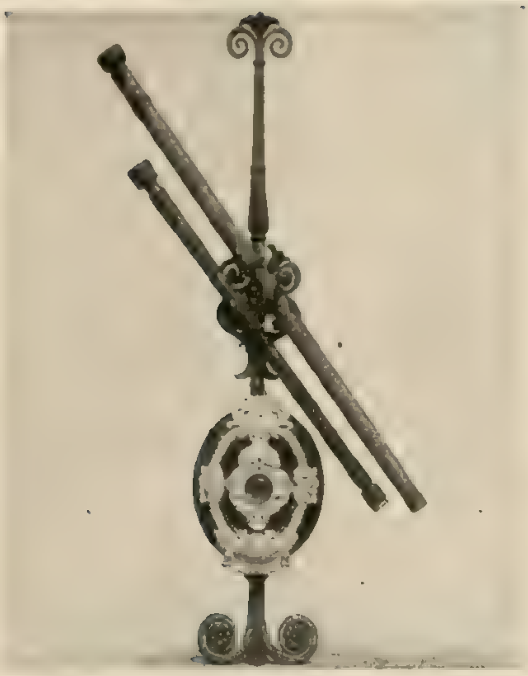
A 16TH-CENTURY ASTROLABE

The astrolabe could be used for determining the time by sighting the altitude of a heavenly body and reading tables and dates engraved on the instrument.

In 230 B.C. Eratosthenes, at Alexandria, measured the obliquity of the ecliptic (i.e. the angle between the plane of the Earth's equator and the plane in which the Sun appears to move) and obtained 23° 51′—only 5′ too big (*see* Astronomy, Modern, Fig. 1). He also measured the circumference of the Earth with considerable accuracy. Measuring instruments were by now reaching a considerable degree of refinement, and a form of astrolabe, for measuring the height of stars above the horizon, was in use by 200 B.C.

Hipparchus (*c.* 190–120 B.C.) listed the positions of over 1,000 stars on the 'celestial sphere' —which is formed by imagining the lines of latitude and longitude, by which positions on the Earth are stated, to be extended outwards into space. He also measured 'precession'—the slow circular swing of the Earth's axis, which makes one complete turn every 25,800 years (*see* Astronomy, Modern, Section 4).

By A.D. 140 Ptolemy had established the fact that the Earth is round—the famous ship-over-the-horizon argument is his; but he taught that the Earth was at the centre of the universe (the 'geocentric system'), and that it did not move.



ONE OF THE EARLIEST TELESCOPES, BELIEVED TO HAVE BEEN MADE BY GALILEO
Florence, Museo di Fisica e Storia Naturale. *Alinari*

He explained the motions of the planets by regarding each as revolving round a circle of its own, the centre of which moved round the Earth yearly. Each centre was supposed to be on an invisible globe which revolved daily on an axis through the Earth's centre. The scheme met with success till measurements became more refined, and then the complications which had to be introduced to explain all the facts made the whole system highly artificial and improbable. Ptolemy produced an improved star catalogue. His work, the *Almagest*, remained unchallenged until the time of Copernicus, some 14 centuries later.

The work of COPERNICUS (q.v. Vol. V) (1473–1543) represents a real landmark in the history of astronomy. He it was who first won general recognition of the 'heliocentric' or Sun-in-the-middle system. His theory met with the opposition of the Church; but he finally published it in a book, the first printed copy of which reached him on his death-bed.

The history of astronomy now begins to crowd with important dates and names, among the first and greatest of these being Tycho Brahe (1546–1601) at his observatory in Denmark. Although he never came to accept the heliocentric system he dedicated his life to the making of accurate measuring instruments and to their use in compiling tables of the planetary orbits.

In the meantime GALILEO (q.v. Vol. V) (1564–1642) was collecting by actual observation evidence which led him to support the theory of Copernicus. Having heard of a Dutch instrument which magnified distant objects, he, too, made a telescope, and with this he studied the Moon's blemished surface and the Sun's spots (quite blasphemous thoughts in those days), whilst the sight of Jupiter's moons showed him a Copernican system on a small scale. Saturn's 'rings' were seen, though not clearly, partly because they were in their edge-on position. The moon-like phases of Venus were noted too as a further striking proof in favour of Copernicus.

These discoveries produced great hostility from the Roman Catholic church, and in 1632, when Galileo's work was published, he was summoned to Rome and, old and infirm as he was, under the Inquisition was driven to write a recantation.

The next great name is that of KEPLER (q.v. Vol. V) (1571–1630), a great mathematician, who was appointed in 1601 to be Tycho Brahe's assistant at Prague University. He completed the former's Tables for Mariners; but his main contribution was that from these Tables he worked out mathematically the laws governing the movements of the planets (*see* PLANETS, Section 1).

In 1675 Charles II founded the Royal Observatory at Greenwich, intended mainly to benefit navigators in the first place, and appointed the first Astronomer Royal. The distinguished work carried on there has gone far beyond the intention of assisting marine navigators. For instance, the meridian telescope has been chosen to fix the zero of longitude for the whole world. The growth of London has now made the position of the observatory unsatisfactory, and it is being transferred farther out into the country.

Further improvements in telescopes came when the Dutch physicist Huyghens (1629–95) applied his ingenuity to the problems. It was he with his more powerful telescope who saw clearly the true nature of Saturn's rings.

It is not possible here to give any adequate idea of the great work of Sir Isaac NEWTON (q.v. Vol. V) (1642–1727). Astronomy owes to him the Law of Universal GRAVITATION (q.v.),

THE 200-INCH PALOMAR MOUNTAIN TELESCOPE

This is the largest Reflecting Telescope in the world. It was completed in 1948 at a cost of over 6½ million dollars, for the observatory on Palomar mountain in California. Of its seven mirrors, the largest is 200 inches in diameter, and weighs 14½ tons. The whole instrument, 500 tons in weight, is delicately balanced on oil bearings, and its movements are controlled automatically, so that when set it can follow exactly the path of a star across the heavens. With this telescope, objects can be photographed 1,000,000,000 light years from the earth. *California Institute of Technology, Pasadena*

which he deduced largely from Kepler's Laws; the discovery of the Sun's spectrum (*see* LIGHT); and the invention of the Reflecting Telescope (*see* TELESCOPE, Vol. VIII). Each of these has led to immensely important developments.

Another important advance in instrument making came in 1757 when Hadley's SEXTANT (q.v. Vol. IV) became the standard device for measuring the altitude of a heavenly body from an unsteady base, such as a ship at sea. 1779

TYCHO BRAHE IN HIS OBSERVATORY
17th-century engraving
Crown copyright reserved

saw the making of a great new telescope by Herschel, and the consequent discovery of a new planet, Uranus. But even more important was this astronomer's study, extending over almost half a century, of the fixed stars and the universe around them. He it was who discovered the movement of the Sun through space, and in general it may be said that he did for the star system what Galileo did for the planets. In 1838 it was first found possible to measure the distance to a few of the nearer fixed stars with fair accuracy, and in that year three such distances were determined.

In 1851 Foucault's pendulum was used to give the first direct proof of the rotation of the Earth. A similar instrument can be seen in use to-day in the Science Museum at South Kensington. The second half of the 19th century brought with it, too, the use of the spectroscope in astronomy (*see* COLOUR). This made it possible to discover the presence or absence of the different chemical elements in the stars, to prove that certain of the nebulae were gaseous and not just infinitely distant star formations, and even to find out the speeds of certain remote stars.

The application of photography to telescopes and spectroscopes has perhaps been the greatest recent advance in astronomical instrument making. Long exposures, using specially mounted telescopes which can be set to follow by mechanical means the path of any body in the heavens, enable us to detect objects too dim ever to be seen by eye; and a sequence of photographs is invaluable for tracing small changes of position, which provide documentary evidence for later study and measurement. Finally there came the publication by EINSTEIN (q.v. Vol. V) of his theory of RELATIVITY (q.v.), completed in 1915 and established beyond doubt during the eclipse of 1919 (*see* ECLIPSE). Though its practical effect on astronomical calculations is extremely small, Einstein's contribution to astronomy is at least as revolutionary as Newton's, which it corrects and to some extent supplants. By revolutionizing our idea of TIME, SPACE, and GRAVITATION (qq.v.) it has led to a quite new approach to problems in physics and astronomy.

See also ASTRONOMY, MODERN.

ASTRONOMY, MODERN. **1.** From earliest times one of the chief concerns of astronomers has been to try to explain the movements of the various bodies in the sky. It was only natural at first, as they noticed the courses followed by the Sun and Moon or the steady drift of the stars, that they should have thought the Earth to be the centre around which all these revolve (*see* ASTRONOMY, HISTORY OF). If we are sitting in a train at rest in a station, and a train alongside commences to move out, it is not easy for a moment or two to say whether our own compartment is moving or the one we are looking at through the window.

Astronomers to-day have still to work chiefly by what are called 'apparent' movements—the movements which the heavenly bodies appear to have when seen from the Earth. We can still say with some truth that the Sun and Moon 'rise in the east and set in the west'; but it is not difficult to see for ourselves that this is not true of the stars: one of them, the Pole Star, shows very little movement, and the stars near it do not rise and set, but move in circular paths round it. Again, though most of the stars in the sky keep their positions in a set pattern which

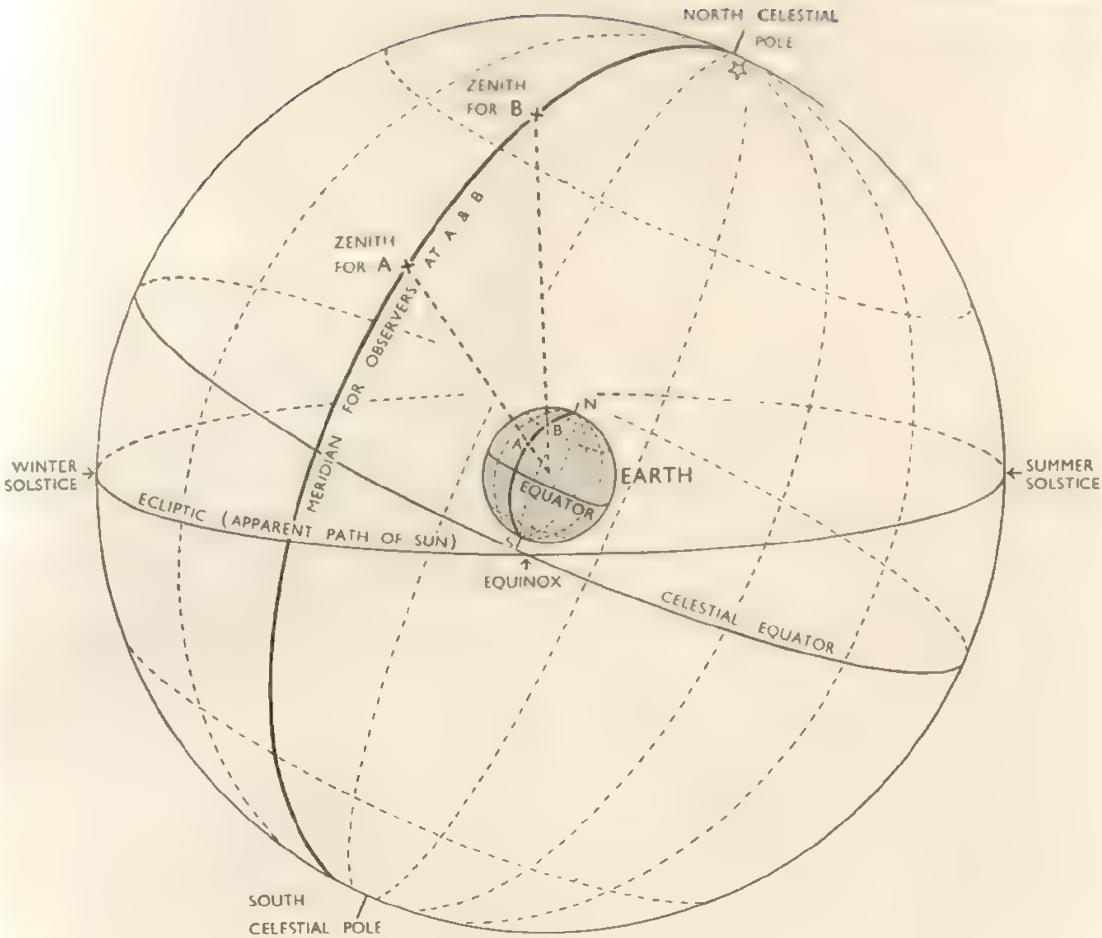


FIG. 1. THE CELESTIAL SPHERE

revolves round the Pole Star but does not otherwise alter, it is not difficult to observe that there are several bright bodies, looking like large stars but having a rather more steady, non-twinkling light, which do not keep their positions in this pattern. These are called planets (or 'wanderers'), and some of them—Venus, Mars, Jupiter, and Saturn—are easy enough to watch even without a telescope.

We now think of the Sun as the centre of the solar system—a great, hot, shining star around which the Earth and the other cool, solid planets revolve. It is by reflecting some of the Sun's light that they become visible. The other stars are thought of as bodies similar to the Sun, but almost inconceivably farther away. The distance between our own solar system and even the nearest of the stars is so vast that almost the only movement the stars seem to have is that caused by the daily rotation of the Earth on its own axis. And so astronomers speak of them as the 'fixed' stars and regard them as a permanent background against which all other movements can be measured.

The fixed stars are, of course, at different distances from the Earth; but these distances are all so enormous that for practical purposes they can be called 'infinity' and so be regarded as equal. Astronomers, then, think of the stars as points on an infinitely great ball which they call the 'celestial sphere'. Our own equator and poles are imagined as projected outwards and drawn on the sphere to give the 'celestial equator' and 'celestial poles'. Lines similar to those of latitude and longitude can also be imagined on it by which to fix positions (Fig. 1).

The stars are also grouped into CONSTELLATIONS (q.v.) to make them more easily identified.

Let us now take the apparent movement of this celestial sphere with the apparent movements of the Sun, Moon, and planets inside it, and see how they agree with our idea of the solar system. We shall assume that we are watching the sky from a latitude like that of England.

2. APPARENT MOVEMENT OF THE STARS. If there were a star P (Fig. 2*a*) exactly on the line of the Earth's axis, an observer at O, travelling round as the Earth rotated, would always see it in the same direction, true north, and at the same height (or angle of altitude *a*) above his horizon. The Pole Star is very nearly in this position, and so it is a great help to navigators in finding their direction at night. Other stars, like C in Fig. 2*b*, would change their direction and altitude (from $a°$ to $b°$) during the night as the observer moved along with the Earth's rotation. For some stars, like R in Fig. 2*c*, the light would not always be able to reach the observer —his view being cut off at times by the Earth itself. He would say that the star had 'set' when he got round to the point marked Q. Stars like C, which are always above the observer's horizon, are called 'circumpolar' stars. The others appear to rise and set daily.

But is it not surprising that the apparent movement of the stars is as simple as it is? If

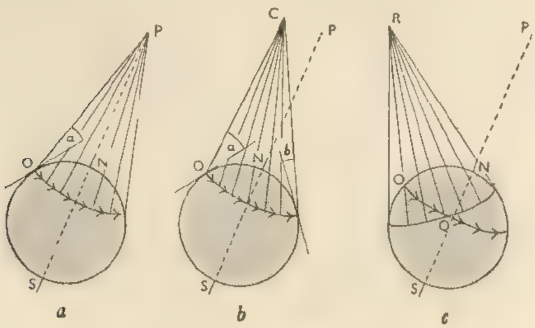


FIG. 2. APPARENT MOVEMENT OF STARS

the stars are scattered in space, surely we should expect to see the pattern change as we turn round daily with the Earth—or at least as we move along its far larger annual orbit round the Sun. When we watch a group of trees as we pass in a train they appear to change their positions, the nearer ones moving faster than the more distant ones (Fig. 3). This apparent movement, which is called 'parallax', must not

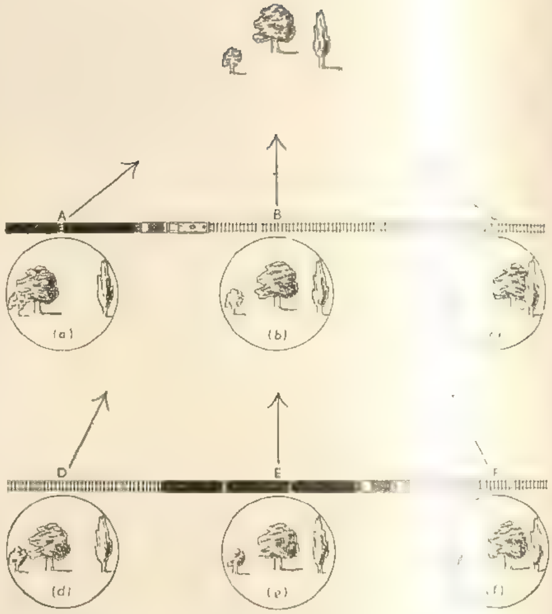


FIG. 3. PARALLAX

An observer in the train at A, B, and C sees trees grouped as *a*, *b*, and *c*. To an observer in a more distant train at D, E, and F, the parallax is much less marked (*d*, *e*, *f*)

be confused with the simple apparent movement of the group as a whole: parallax is the apparent change of position of the trees among themselves owing to the different viewpoints of the observer. But no such movements can be seen by eye amongst the stars, and even delicate astronomical instruments show very little of it even for the whole yearly movement of the Earth round the Sun. This is because the stars are so immensely far away that even the diameter of the Earth's orbit (about 186,000,000 miles) is a mere nothing in comparison. For the same reason the stars' own real movements among each other can hardly be seen, the most rapid example known amounting to no more than a distance equal to the Moon's diameter in 180 years, although the speed is something like 1,000 miles a second! In ASTRONOMY, MEASUREMENTS OF an account is given of the way in which parallax is used by astronomers.

3. APPARENT MOVEMENTS OF THE PLANETS. Those planets which are nearer to the Sun than the Earth are called the 'inferior' planets; those farther away are called the 'superior' planets (*see* PLANETS). The inferior planets, Mercury and Venus, move faster than the Earth, and show, like the MOON (q.v.), complete sets of 'phases', or areas made visible by the Sun's light;

the superior planets move slower and never show phases so small as one-half (*see* PLANETS, Fig. 3).

If a superior planet is observed for a number of years it will be seen that, as well as its nightly rising and setting (which are due to the Earth's own rotation, of course) it also moves slowly across the background of fixed stars in a series of loops as in Fig. 4*a*. To understand this let us

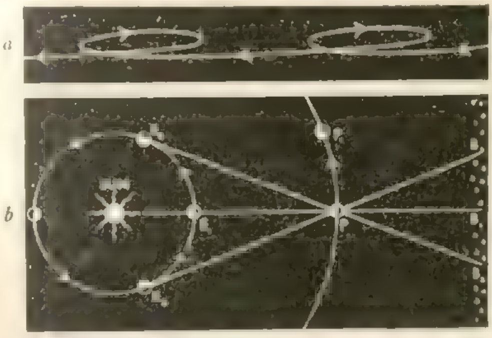


FIG. 4. APPARENT MOVEMENT OF THE PLANETS

first suppose that the planet is not moving round the Sun at all. Now as the Earth moves round in its orbit from E_1 to E_2 (Fig. 4*b*), the planet P will appear to drift across the background pattern of stars from B_1 to B_2, when it will halt and start back towards B_1, halting again at B_3, and so on, back and forth each year. Now if the planet's orbit round the Sun were on exactly the same level as the Earth's orbit, this movement would be 'sideways' along a line; but as the orbits of the various planets are at a slight angle to one another there is an 'up and down' movement as well, which causes the track to spread out like an oval.

Now let us add the effect of the planet's movement in its own orbit. During the year the planet will have moved from P to (say) P_1. So the next oval will not overlap the former one, but will be in a new place. Thus Saturn, which takes about 30 years to go once round the Sun, makes 29 loops during the journey.

The apparent movement of the inferior planets across the background of stars consists (in addition to the nightly rising and setting) of an oval round the Sun and is mainly due to their own orbital motions. The motion of our own Earth also affects the motion of the inferior planets much as described in the case of the superior planets. The effect of phases on the apparent brightness of a planet is described in the article on PLANETS.

4. APPARENT MOVEMENT OF THE SUN. The apparent eastward movement of the Sun against the background of fixed stars cannot actually be seen by the eye because of dazzle; so observations are taken exactly at midnight, and these give a reverse picture of the daytime movement. The circuit is completed in one year (*see* CALENDAR) and the apparent path of the Sun is called 'the ecliptic', shown in Fig. 1. It is inclined at an angle of about 23½° to the equator. The paths of the planets, and of the Moon, all lie within a belt 9° wide on either side of the ecliptic, and this belt is called 'the Zodiac' (*see* CONSTELLATIONS).

Owing to 'precession', or the slow circular swing of the Earth's axis described in the article EARTH, the two points where the ecliptic cuts through the celestial equator move slightly each year, making one complete circuit of the equator once every 25,800 years. These points are the 'equinoxes' (*see* Fig. 1), the two days in March and September when the night is equal in length to the day all over the world. So the phrase 'the precession of the equinoxes' is often used to describe the movement, though it might equally well be called 'the precession of the solstices', these being the two days at midsummer and midwinter when the Sun is farthest from the celestial equator (and the shadows cast by the Sun at noon, therefore, the longest and the shortest of the year) (*see* CALENDAR).

5. APPARENT MOVEMENT OF THE MOON. The apparent eastward movement of the Moon across the background of stars is very quick. In 1 hour it drifts a distance about equal to its own diameter, and it reaches its highest point in the sky about 51 minutes later each successive night. After about 27½ days it will be back at the place it first occupied; but as the Sun will have moved a little way along the ecliptic during this time, the Moon's phase will now be different. It takes about 2 more days for the Moon to make up this distance, and so the phases repeat themselves approximately every 29½ days. The Moon also climbs higher or lower in the sky according to the season of the year, reaching its highest point in the night sky at midwinter.

6. We see, then, that the heliocentric or sun-in-the-centre system explains every movement we see in the sky. It was KEPLER (q.v. Vol. V), early in the 17th century, who first worked out the laws of planetary motion, which enable astronomers to calculate the position in its orbit of any

planet at any time past, present, or future, and NEWTON (q.v. Vol. V) who described the movements of all heavenly bodies as being due to the force of GRAVITATION (q.v.). The principles established by these two great men are still accepted by astronomers as accurate enough for almost all purposes; but in the present century the acceptance of Einstein's theory of RELATIVITY (q.v.) has shown the older principles to be true only to a certain extent, since they are based on an incomplete and too rigid idea of the universe. The origin of the heavenly bodies and of their movements has not yet been—and may never be—fully explained; but it seems probable that the solar system originated in the approach of some great star to the Sun, from which its gravitational pull detached certain portions, leaving them to continue revolving round the parent body as planets. In some such way, too, the Sun itself is believed to have detached the Moon from the Earth.

See also CALENDAR; ASTRONOMY, MEASUREMENTS OF; ASTRONOMY, HISTORY OF; COMETS; CONSTELLATIONS; EARTH; EARTH, HISTORY OF; ECLIPSES; METEORS; MOON; NEBULAE; PLANETS; STARS; SUN; TIDES; UNIVERSE.

ASTRONOMY, MEASUREMENTS OF. 1. The distances with which astronomers have to deal are often so vast that the word 'astronomical' is commonly used to describe any staggeringly large number. The Moon is a mere quarter of a million miles away from us, and even the distance between the Sun and planets of our solar system can be reckoned conveniently in millions of miles; but when we come to the unimaginably vast stretches of space separating us from the stars and, still more, from the great NEBULAE (q.v.), the mile becomes an awkwardly small unit. In its place astronomers use the 'light-year', which is the distance travelled by LIGHT (q.v.) in one year. Now, light travels at the rate of 186,000 miles a second—so it is easy to realize that a light-year must be a very large distance indeed: it is, in fact, equal to about six million million miles—or roughly sixty-three thousand times our distance from the Sun. So a light-year is a truly 'astronomical' figure to take as a unit of measurement. And yet we know of nebulae which are more than a hundred million light-years distant from our own solar system!

How do astronomers set about measuring such distances or, indeed, any distance through empty space where ordinary means of measurement cannot be used? Many of their methods are too highly mathematical to be described; but it is possible to give a rough general idea of the way they set to work. We shall start with the easier measurements and go on to the more difficult—which is the way astronomers themselves had to proceed as their knowledge increased and their instruments grew more accurate.

2. THE SIZE OF THE EARTH. It seems that as early as 230 B.C. a Greek astronomer measured the circumference of the Earth, using a method very much the same as that used to-day. Two observers, A and B in Fig. 1, are stationed about 100 miles apart on the same line of longitude. If this line of longitude is assumed to be projected outwards into space it can be imagined as a vast circle in the sky stretching from above the observers' heads and going right round beneath the globe under their feet: this is called their 'meridian' (*see* ASTRONOMY, MODERN, Fig. 1). They choose for their observation some star which will cross their meridian at a suitable height and time as the Earth rotates on its axis. At the moment of 'transit' or crossing, each observer measures the angle between the star and a point, called the 'zenith', vertically above

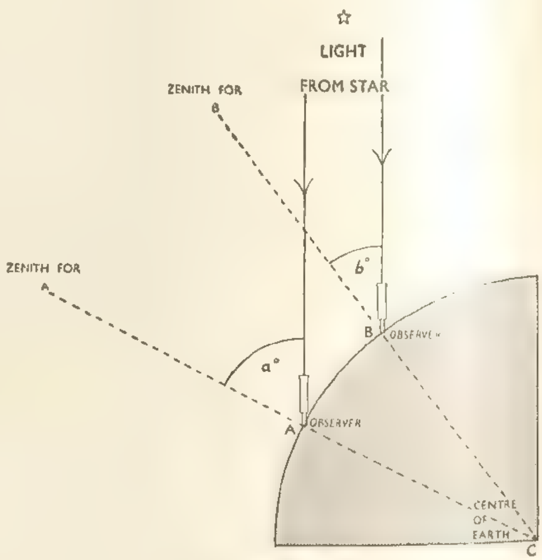


FIG. 1. MEASURING THE EARTH'S RADIUS

his head. These are the angles $a°$ and $b°$ in Fig. 1.

The rest is done by geometry. The observers know exactly the distance separating them (A to

B′; and now that they also know the sizes of the two angles $a°$ and $b°$, it is not difficult for them to calculate their own distance from C, the centre of the Earth (A to C, or B to C). This gives them the Earth's radius, from which they can work out its diameter, circumference, or volume.

The Earth is not a true sphere, however (even if we neglect the irregularities of mountains and valleys on its surface), nor indeed any simple geometrical shape. It has a bulge round the equator and is slightly flattened at the poles. The best measurements, taken in 1909, gave the radius at the poles as 3,950 miles and, at the equator, 3,963 miles.

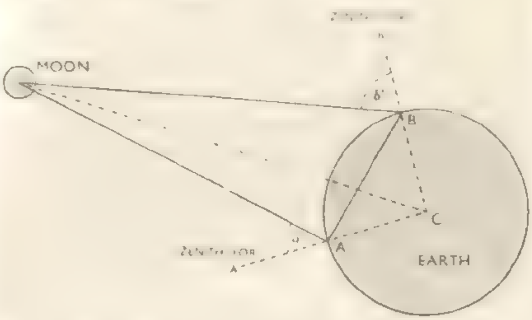


FIG. 2. MEASURING THE DISTANCE OF THE MOON FROM THE EARTH

3. THE DISTANCE OF THE MOON. This is measured in very much the same way (*see* Fig. 2). Two observers measure the angles $a°$ and $b°$ between the verticals and (this time) the Moon just when it crosses the meridian. As before, they know the distance AB between their two observatories; and, as already described, they now know also the length of the Earth's radius, C to A (or B). From these figures the distance from C to the Moon is calculated. This is 253,000 miles as a maximum and 222,000 miles as a minimum distance—the Moon's orbit round the Earth not being a true circle.

4. THE DISTANCE OF THE SUN. This is one of the most important of all measurements, as so much else depends on it. The search for the best method of measurement has been a long one; but the three main methods are:

(*a*) Now that the speed of LIGHT (q.v.) has been measured very accurately by experiments of a non-astronomical kind, use can be made of this, with the times of eclipses of Jupiter's moons, to calculate the Sun's distance from the Earth.

(*b*) In 1716 the astronomer Halley suggested that the 'transit' or passing of Venus across the

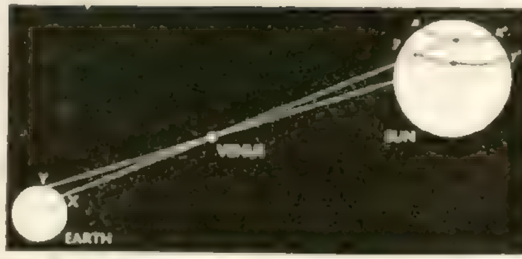


FIG. 3. CALCULATING THE DISTANCE OF THE SUN FROM THE EARTH BY OBSERVING THE TRANSIT OF VENUS

Sun's disk could be used. He suggested that two widely separated observers on the same line of longitude should time the movement of Venus (Fig. 3) across the background of the Sun's disk. Observer X would see the transit along *xx′*, and observer Y along *yy′*. From the times of these two crossings and the knowledge we have about the speed of movement round the Sun of the Earth and Venus, it is possible to calculate the distance required. The next transit was due in 1761; but unfortunately the astronomer did not live to see his experiment carried out. The weakness of this method is that it is difficult to tell within a few seconds the exact moment of the contact of Venus with the edge of the Sun.

(*c*) Mars and some minor planets come especially near to the Earth when the orbits happen to be placed as shown in Fig. 4, with the Earth (E) at its farthest from the Sun and the planet (P) at its nearest to the Sun. If the distance EP were known, all the other distances in

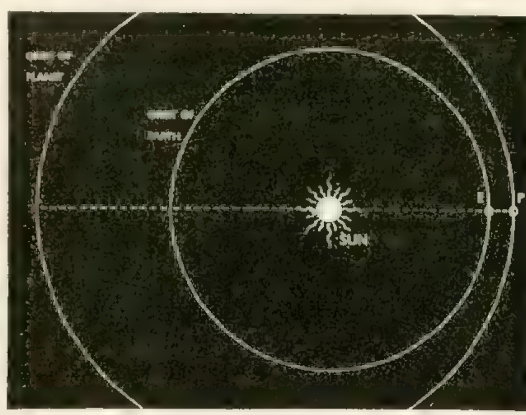


FIG. 4. THE NEAREST OPPOSITION OF THE PLANET EROS

the diagram could be calculated mathematically by using Kepler's Laws of Planetary Motion (*see* PLANETS, Section 1). In 1931 the minor

planet Eros came within about 16 million miles of the Earth and gave a particularly good chance of measuring the distance EP accurately. Photographic methods were used, similar in principle to that used in measuring the Moon's distance (*see* Fig. 2). The result gave the Sun's distance from the Earth as 93,005,000 miles.

5. THE DISTANCE OF THE PLANETS. (*a*) One of Kepler's laws tells us that the length of the 'year' for any planet and its average distance from the Sun are connected by a fixed mathematical relation. Now in the case of our own planet the Earth, both the year's length and the average distance from the Sun have been measured very accurately—and so we know what this relation is. Astronomers can tell by observation the length of any planet's year; so that from this and the mathematical relation they can easily calculate the distance between the planet and the Sun.

(*b*) The method shown in Fig. 2 for measuring the Moon's distance can be applied; but the planets are too far away for this to be very accurate.

6. THE DISTANCE OF THE STARS. The stars are all much too far away for their distances to be measured by any of the methods described up to now; but a few of them are near enough to allow the use of what is called the 'parallax' method. When we look at a group of trees from a moving train or car, they seem to change position as we pass by, the nearer ones appearing to slide backwards more quickly than those farther away. This apparent change of position caused by our own movement is called 'parallax' (*see* ASTRONOMY, MODERN, Section 2). The stars are all so very, very far away that no such relative movement among them can be seen with the naked eye, even though the Earth changes its position by a distance of roughly 186 million miles as it travels round the Sun. But some of the stars are just near enough for parallax to be seen and measured with the help of very delicate instruments. This means that their distances can be worked out by a method rather like that shown in Fig. 3—except that instead of using two observers 100 or so miles apart on the Earth's surface, the same observer takes a reading and then waits half a year for the Earth to carry him 186 million miles before he takes a second reading. Fig. 5 shows how this parallax method is carried out.

A star, s, is taken, and also another star which is presumed (by its faintness, or for some other reason) to be very much farther away—'at infinity', as we say. In 6 months, as the Earth goes round the Sun, the angular distance between s and its distant companion will vary from x° to y°. From these two angles the distance from s to the Sun can be calculated. To-day the angles x and y are worked out from photographs; but when the first star distances were measured in about 1836 less accurate methods had to be used. The distances of several thousand stars have now been measured in this way, and it appears that the nearest star is 4·2 light-years away.

More distant stars cannot be dealt with by parallax, because they are too near to 'infinity' to be compared with stars even more distant still; but in the case of some stars of a certain kind called 'variables', another method of calculation can be used. Variable stars are so called because their brightness varies in a systematic way. It was discovered that with some variables there is a definite mathematical connexion

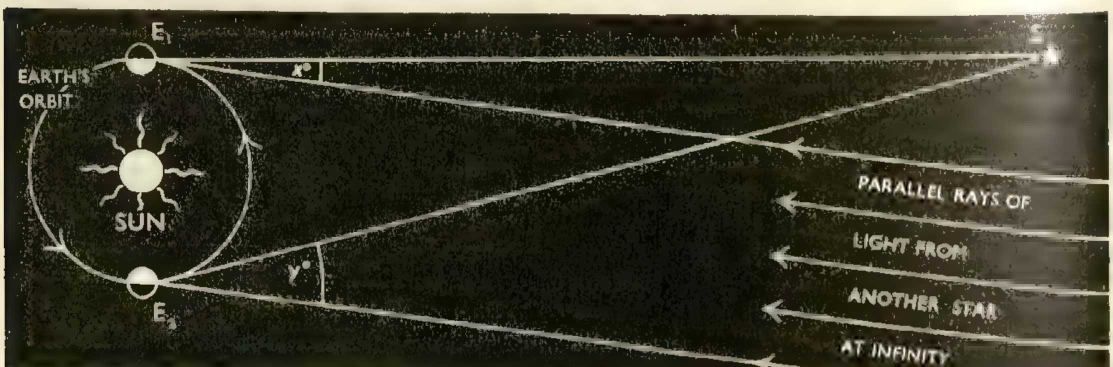
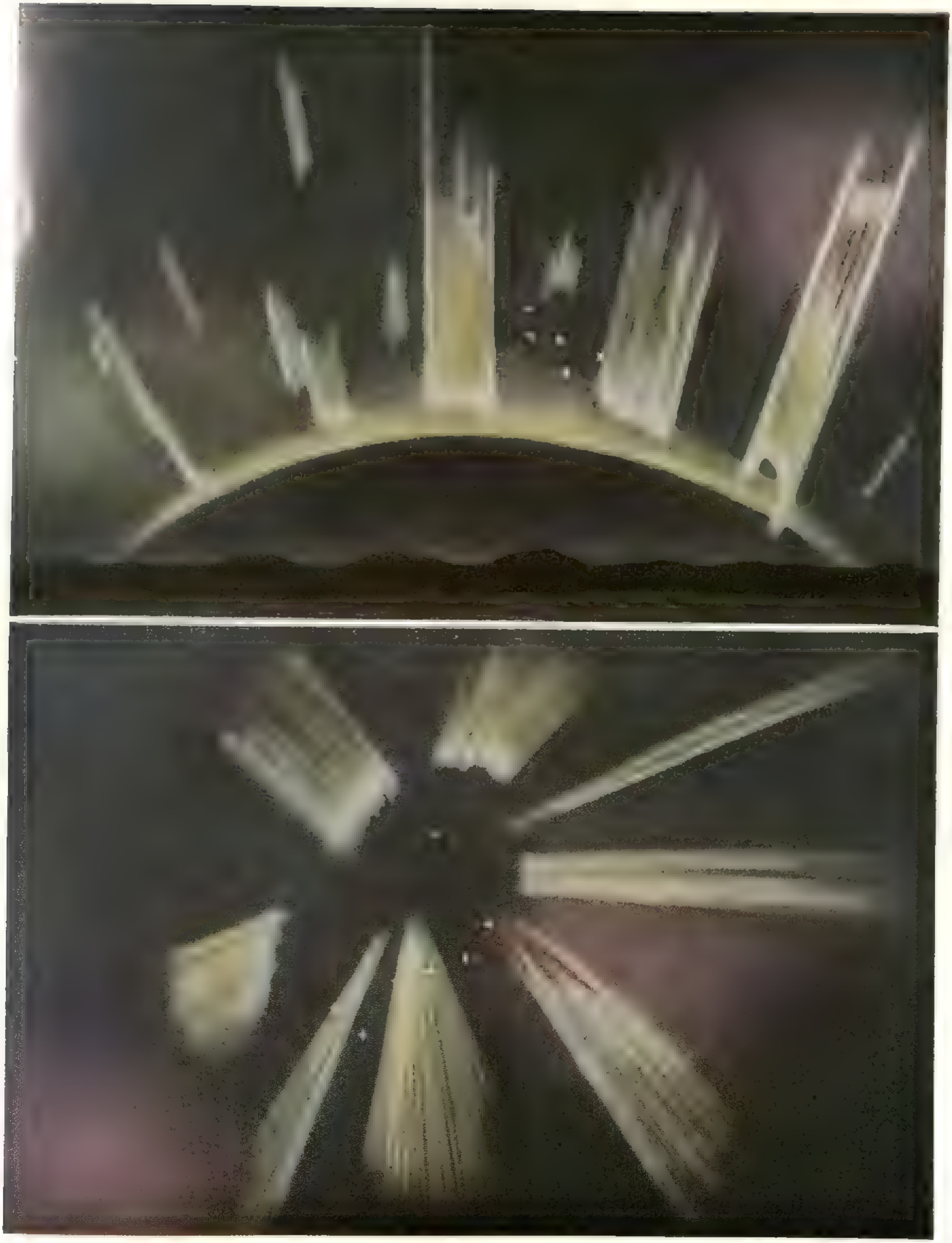


FIG. 5. CALCULATING THE DISTANCE OF A STAR BY THE PARALLAX METHOD



THE AURORA BOREALIS *Drawn by Peter Hood*

1. A large display of the Aurora often begins with the appearance of a low arc of light above the horizon towards the magnetic north. As this arc brightens and rises higher, many coloured rays develop. Soon the whole pattern may break up into separate curtain-like rows rising upwards

2. As a climax to the display, the rows of colours gather together to form a 'corona'. The streamers may be 300 miles overhead, and their appearance of coming together is the effect of perspective

between the brightness and the period. Just how this discovery makes it possible to calculate the distances of some of these variables is too complicated to be described here; but the calculations have been made, and show some of these stars to be almost 100,000 light-years distant from the Earth.

A third method of estimating the distances of stars is by the use of the spectroscope (see Colour). Exactly similar energy distributions in spectra are thought to indicate stars of equal 'real' brightness; and so, if one star shows a spectrum exactly like that of another whose distance is known, its distance too can be worked out from measurements of its 'apparent' brightness. The spectroscope is also used by astronomers for obtaining data to calculate the speeds with which some stars are moving in relation to the Earth. The method used is described in WAVE MOTION—5: Doppler Effect.

See also EARTH; MOON; PLANETS; SUN; UNIVERSE.

ATACAMA DESERT, *see* DESERTS; CHILE.

ATHENS. On the site of Athens, the capital of Greece, once stood the most famous city of Ancient Greece—yet the city to-day has little feeling of antiquity. During the Turkish oppression of the 18th century Athens was reduced to a few hundred houses, and the modern city has been built up since that time. Evidence of the Turkish occupation remains in the streets and houses on the north slopes of the Acropolis, which are attractively Turkish in character. Two streets are all that remain of the Turkish bazaar in the city, the streets of smiths and of cobblers, narrow and noisy and dim. The lovely little Byzantine church of St. Theodore, a very ancient foundation but rebuilt in the 11th century, reminds us that for some centuries Athens was part of the BYZANTINE EMPIRE (q.v. Vol. I).

Modern Athens was built mainly in the mid-19th century to a plan of squares, broad avenues, and gardens. Constitution Square is the hub of the city. In it are the Royal Palace, the principal hotels, and the famous Zacharatos Café which never shuts. Athenians use cafés almost as though they were clubs. On summer evenings the pavements in front of them are gay with parties eating sweetmeats and ices, and drinking tea, coffee, wine, or beer. In the streets which lead from Constitution Square there are

ATHENS

The Acropolis towers high above the city.

Prof. B. Ashmole

museums, the University, and the National Library.

Piraeus, the port of Athens, is, like most ports of the eastern Mediterranean, rather squalid, overcrowded, and dirty. Its harbour facilities are adequate, and there are factories and workshops. Between Piraeus and Athens lies the suburb of New Phalerum, a bathing resort with good restaurants and hotels.

Modern Athens is built among hills—high peaks quite close to the city, on which stand the ruins of ancient Athens, the city of Athena the goddess of wisdom. The rugged, cliffed rock of the ACROPOLIS (q.v. Vol. XII) towers high above everything, crowned by the ruins of temples and the Propylaea, the gateway to the citadel, and with the Great Theatre of Dionysus at its foot.

The bare Areopagus was the hill where the Council of State held its sittings, and where, later, St. Paul addressed the Athenians; rocky Pnyx, with its vast auditorium cut in its side, was where the citizens of the 5th and 4th centuries B.C. met in assembly; while a lower hill is topped by the Theseum or Temple of Hephaestos, the god of fire, the most complete Greek temple in existence. On the site where the Greeks built the Erechtheum Temple, the most sacred part of the Acropolis, a contest is supposed to have taken place between Athena and Poseidon as to who should possess the land of Attica. The prize was to go to whichever presented the inhabitants with the most valuable

gift. Athena presented the olive-tree and was acclaimed the victor.

The history of Athens is very old. According to the legend, it became a powerful united state under Theseus, King of Athens (*see* GREEK HEROES, Vol. I). In the 5th century B.C. a revolution took place against autocratic government, and the famous Athenian democracy evolved. The 5th and 4th centuries B.C. were the greatest periods of Athens' history. After the Athenians had driven off the Persians who had devastated the city in the early 5th century, Athens became the leading state in Greece, and very wealthy. Most of the famous buildings belong to this period, and were built as part of Pericles' scheme for beautifying the city. After the death of PERICLES (q.v. Vol. V) the power of Athens began to decline. In the 4th and 5th centuries, the era of SOCRATES, ARISTOTLE, and PRAXITELES (qq.v. Vol. V), she led the world in culture, but her political power was on the wane. Even when she became a Roman province in 27 B.C. she retained much of her intellectual prestige. This lingered on until A.D. 529, when the Emperor Justinian ordered the closing of her schools of philosophy.

See also GREECE.
See also Vol. I: GREEK CIVILIZATION; GREEKS.
See also Vol. XII: GREEK ART.

ATLANTIC OCEAN, *see* OCEANS.

ATLAS MOUNTAINS, *see* ALGERIA; MOROCCO.

ATMOSPHERE. The layer of gases, between 100 and 200 miles thick, surrounding the Earth. 'Air' is not (as water is) a chemical substance in itself: the word is just a general name for the gases present. In an average sample of air at sea-level these are: nitrogen, 78·08 %; oxygen, 20·95 %; carbon dioxide, 0·03 %; hydrogen, 0·01 %, and traces of the inert gases argon, helium, neon, krypton, and xenon. There are also varying amounts of WATER VAPOUR (q.v.) and dust.

Below a height of 10 miles the atmosphere is warmed only very slightly by the direct rays of the sun: it gains most of its warmth when these are reflected back, on a longer wave-length, from the earth's surface. Consequently, the air gets more or less steadily colder with height—at the rate of about 1° Fahrenheit for each 300 feet, though many irregularities are usually found. Airmen flying at anything over 10,000 feet (or 2 miles) have to wear very warm clothing, and at 6 or 7 miles the temperature is usually about 60° below zero—or near 100° of frost. It used to be thought that this drop in temperature continued with increasing height: but observations made with recording thermometers attached to balloons show that above 6 miles the air ceases to grow colder, and even becomes rather warmer at higher levels. (This figure is for the British Isles; at the Equator it is about 11 miles, and at the Poles about 4 miles.) The level at which this change in behaviour occurs is called the 'tropopause' (Gk. *tropos*, a turning), the layer of air below it is called the 'troposphere', and the 40- or 50-mile layer above it is the 'stratosphere' (Lat. *stratum*, a layer). Above this again is the 'ionosphere', so called because the chief thing known about it is that it contains quantities of 'ions' or electrically charged particles (*see* ATOM). It is in the ionosphere that displays of AURORA (q.v.) occur, and here, too, is the 'heaviside layer' which reflects wireless waves and so makes radio-communication round the circle of the globe possible. The air in the ionosphere and the stratosphere is so very rarefied that METEORS (q.v.) do not encounter enough friction to heat them to incandescence, and so make them visible (*see* Fig. 1).

The air in the troposphere is rarely still. Apart from the horizontal movements which we notice as WIND (q.v.) there are continual up-and-down movements which (unless we are flying) can only be detected by their influence in forming CLOUD (q.v.). These are called 'convection' currents. As warmer air always tends to rise above cooler (*see* HEAT, Section 3), the fact that the atmosphere is normally warmest near the ground means that there is a continual tendency for the lower layers of air to rise and to be replaced by the cooler layers from above. This tendency continues right up to the tropopause, where it ceases, because in the stratosphere temperature no longer continues to fall as height increases, and so convection currents cannot occur. For this reason it had been expected that aircraft flying in the stratosphere would find no 'bumps' or 'air-pockets' such as are met with at lower levels. However, it has recently been discovered that, for some reason not yet understood, very violent disturbances do exist in the stratosphere, so violent as to be dangerous.

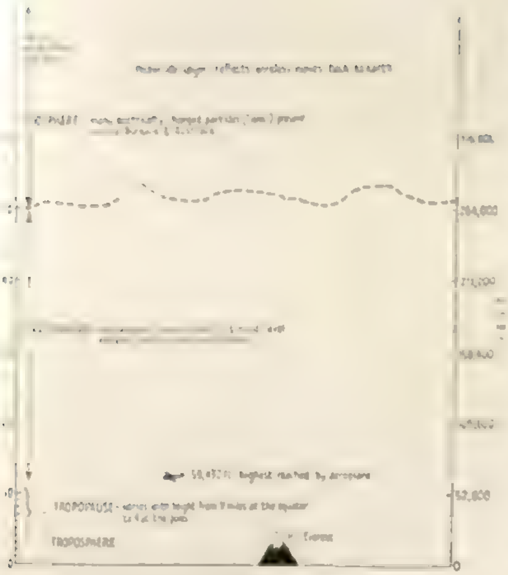


FIG. 1. THE ATMOSPHERE

Research into the reasons for these is at present being carried out—but we can at least be sure that they are not due to normal convection.

Apart from the general tendency for the lower levels of air to rise above the higher, there are all sorts of variations caused by local conditions which cause unequal heating by the earth's surface. Large expanses of cloud may reduce surface heating considerably, and in any case water reflects back far less of the sun's heat than land, and wooded country far less than sand, rocks, or turfy chalk. Near the poles vast areas of snow and ice cool rather than warm the air above them, while towards the Equator the sun's rays, approaching the vertical, take the shortest way through the atmosphere and so reach the earth with their power less diminished than in more temperate climates. With all these, and many other factors (*see* WEATHER), continually at work, it is not to be wondered at that the troposphere still springs many surprises on our weather experts.

The atmosphere has weight, just as our own bodies have, and consequently it is held to the Earth by the force of gravitation. This means that, like our own bodies again, the atmosphere exerts PRESSURE (q.v.). At sea-level atmospheric pressure is equal to about 1 ton on every square foot. As we climb higher, naturally the pressure grows less, and at 18,000 feet it is only about ½ ton per square foot. Above this height flyers begin to feel discomfort, because however deeply they breathe, their lungs are only getting half the normal supply of oxygen. Climbers, who need more oxygen because of their greater muscular efforts, are apt to become still more distressed. That is why the men on the Mount EVEREST expeditions (q.v.) carried portable oxygen apparatus with them, as do airmen flying at great heights. When Gaston Tissandier, the French scientist, went up in a balloon to 26,500 feet, in 1875, he fainted from lack of oxygen—and, though he recovered consciousness when the balloon sank lower, his two companions died. To-day, pilotless balloons are regularly used to explore the stratosphere, and a Belgian scientist, Professor Piccard, has made several ascents in a balloon with a sealed cabin beneath it; but the ionosphere lies far beyond our reach and can be investigated only by instruments from the Earth's surface.

ATOLL, *see* CORAL ISLANDS.

ATOM. It is now known that matter of all kinds is formed from different compounds and mixtures of a number of basic substances called 'elements', of which there are some ninety-two in nature (*see* MATTER). This was finally proved in the 18th and 19th centuries, and until early in the present century it was believed that these elements, made of tiny particles called 'atoms', different for each different element, were really the fundamental substances, incapable of being split up into anything simpler. We now know that the atoms of all these different elements are made up of yet tinier things, called 'elementary particles', of which there are probably no more than four or five kinds. It is the number and arrangement of these particles inside the atom which give the elements their characteristic properties.

As early as the middle of the 19th century an English chemist, Prout, had noticed that the atomic weights of all the elements then known were, with a few exceptions, exact multiples of that of the element hydrogen, the lightest. He had tried to prove from this that all atoms must be built up in some way from hydrogen atoms. But as the atomic weight of chlorine was 35½—not an exact multiple of that of hydrogen, scientists could not accept his theory. (We shall see later why chlorine included this fraction.) In 1896 a great new discovery was made, purely

by chance. A French scientist, Becquerel, left in his desk a piece of mineral, uranium, near some photographic plates. When he came to examine these he found that in some way they had been affected as though light had reached them. He knew this could not be the explanation, because the plates had been wrapped in black paper and sealed in a cardboard box. It could only be that the uranium had given out rays of some kind which had affected the plates. This led him to the discovery of 'radio-activity', the fact that some of the elements, whether heated or not, steadily give out certain rays or particles (*see* RADIATION). When in 1898 Pierre and Marie CURIE (q.v. Vol. V) extracted from uranium ore a new element 'radium', much more radio-active than uranium, many physicists were attracted to this new line of research.

In 1911 the famous physicist RUTHERFORD (q.v. Vol. V) put forward a new theory of the atom (which was later developed by the Dane Niels Bohr), suggesting that all the atoms of all the different elements were made up of the same two fundamentals, 'electrons' and 'protons'. They held that a proton was a small particle carrying a positive charge of ELECTRICITY (q.v.), and an electron a small particle negatively charged and, compared with a proton, 1,850 times lighter. The atom itself consisted of a central 'nucleus' made up of a number of protons and (as they then thought) electrons, closely bound together in some sort of way and with a positive charge; and round this danced a number of electrons moving in fixed paths or 'orbits', either circular or elliptical, some remaining close to the nucleus and some keeping comparatively far away—in short, a kind of miniature solar system.

The total electrical charge of the moving or orbital electrons was negative enough to balance the positive charge of the nucleus and so keep the atom as a whole electrically neutral. In 1913 the English physicist Moseley made the important discovery that the electrical charge on the nucleus of any element corresponds exactly with its 'atomic number'—or its position in the Periodic Table of Elements arranged in order of atomic weights (*see* MATTER, Fig. 1). For example, the charges on the nuclei of atoms of silver (No. 47) or of uranium (No. 92) are just forty-seven or ninety-two times as strong as that of hydrogen, which, as the lightest element, is No. 1 on the list.

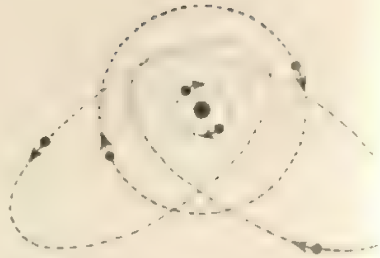


FIG. 1. THE RUTHERFORD-BOHR PLAN OF CARBON ATOM

The theory of Rutherford and Bohr gave a good working picture of the atomic structure (*see* Fig. 1). One of the most important corrections to it has been Chadwick's discovery in 1932 that the other main constituent of a nucleus is not the electron, with its negative charge, but the 'neutron', an electrical neutral particle. Protons and neutrons are now thought to be basically the same, different only in their electric states, and have been renamed 'nucleons'.

The atom, then, is to-day believed to consist mainly of two kinds of particles: the nucleons (protons and neutrons) forming the nucleus, and the electrons encircling it. (The other particles known, 'neutrinos', 'mesons', and 'positrons' or *positively* charged electrons, need be no more than mentioned here.) For the most part an atom consists of empty space, only about one-million-millionth of its bulk being occupied by these particles. Its mass (or, roughly, weight) lies almost entirely in its nucleus, since a proton or neutron weighs about 1,840 times as much as an electron. This suggests that the nucleus must be heavy compared to its size almost beyond imagination—and, in fact, if it were possible to collect one thimbleful of solid nuclear stuff it would weigh no less than 250 million tons!

Normally there is one electron (negative) for each proton (positive) in the nucleus, to keep the atom electrically balanced or 'neutral'. When an atom loses or gains an electron it becomes electrically charged or 'ionized', and it, or a group of such atoms, is called an 'ion'.

It is no longer believed that the electrons move round the nucleus in orbits, like planets round the sun: instead, the new science of Wave Mechanics gives them uncertain patterns to occupy (*see* QUANTUM THEORY). It is believed, however, that they move immensely fast in different layers and that each layer has a definite number of electrons. The layer nearest the

nucleus has two, the second layer not more than eight, the third layer is sometimes complete with eight and sometimes with eighteen, and so on.

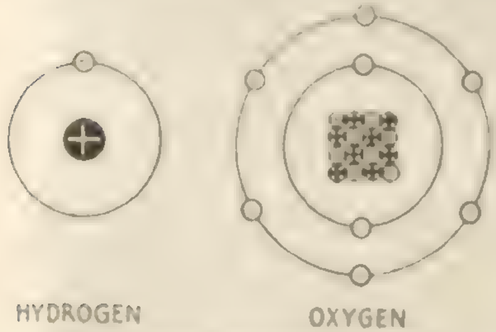


FIG. 2. ATOMS OF HYDROGEN AND OXYGEN

Also, the electrons of any atom fill the layers from the centre outwards; so that if there are not enough available to fill all the layers completely, it is the outer layer which remains incomplete.

It is the shortage of electrons in the outer layer which decides the way in which an element can combine with others to form 'chemical compounds' (*see* CHEMISTRY). The nucleus remains unaltered throughout; but the outer electrons rearrange themselves or transfer to other atoms. Oxygen, for example, has eight electrons, so that its second layer is two short; hydrogen has only one electron: when the two combine, one atom of oxygen seizes two hydrogen atoms to fill up its outer layer. This combination makes one 'molecule', or the smallest possible piece, of water (H_2O) (*see* Fig. 3). Similarly, nitrogen has seven electrons, leaving a shortage of three in the outer layer: so it combines with three hydrogen atoms to form a molecule of ammonia (NH_3).

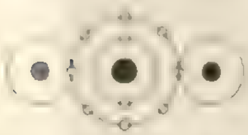


FIG. 3. A MOLECULE OF WATER

There are six elements which never form compounds and so are called the 'inert' (or inactive) gases. This is because all their layers are complete: helium with two electrons, just filling one layer; neon with ten, filling two; argon with eighteen, just filling three, and so on. Thus our new knowledge of the structure of the atom completely explains how the elements are able to combine with each other only in certain ways—explains, that is to say, their 'valency'. It is not difficult to see, too, how it accounts for the way in which the elements can be arranged in [illegible] Periodic Table. This would be [illegible] if each element were distinct and different from every other (*see* Periodic Table, pp. 278-9).

It is only the heaviest elements which are radio-active. Their nuclei are so big that they are unstable and shoot out tiny particles with very high speed—'alpha-particles' (helium nuclei—two protons and two neutrons), 'beta-particles' (electrons), or 'gamma rays' (*see* RADIATION). Thorium and uranium behave in this way, and by doing so they gradually change themselves into different elements. A piece of uranium will gradually degenerate into a piece of lead, although it will take millions of years to do so. In the course of this transition an atom of uranium will become an atom of radium before changing finally into lead (*see* Fig. 4).

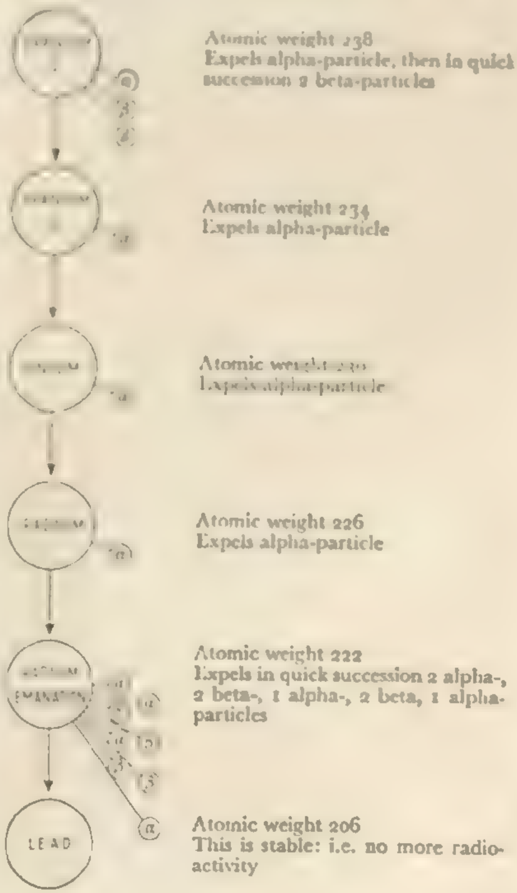


FIG. 4. THE DECAY OF URANIUM TO LEAD

This is the reason that radium is always found in pitch-blende, one of the uranium ores. URANIUM (q.v.) is the heaviest of the known natural elements. But in the atomic bomb factories other elements have been manufactured—among them neptunium and plutonium (Nos. 93 and 94 in the Periodic Table)—which are even heavier; and more are likely to be made in the same way. All these artificial elements are radio-active and unstable.

One last very important discovery was that many elements contain more than one kind of atom. These have exactly the same chemical properties, because they have the same number of protons and electrons; but their weights are different, because they have extra neutrons in the nucleus. The atoms of the same element differing from each other in this way are called 'isotopes'. They were first discovered in 1919, when the British physicist Aston showed that the element chlorine in its usual form has two isotopes, one of atomic weight 35 and the other 37—thus showing why Prout's theory had not been accepted. Hydrogen has been found to have two isotopes, the first with one proton in the nucleus and one surrounding electron, the second with one proton *and one neutron* in the nucleus and one surrounding electron (*see* Fig. 4). The latter heavier isotope of hydrogen is called a 'deuteron' ('deuterium' is 'heavy hydrogen', formed of deuterons only), and when combined with oxygen it forms 'heavy water', a liquid which is denser than normal water.

Almost eighty of the ninety-two elements have now been found to possess isotopes, many of them more than two. Tin, for instance, has no less than ten.

It might have been thought that nothing of practical importance would be gained from studying anything as tiny as the atom. Already, however, it is plain that our new knowledge of the atom may some day be counted as man's most important step forward since he first discovered fire, many thousands of years ago. The terrible power of the atomic bomb has already been demonstrated in warfare; but the peaceful uses to which the new knowledge may be turned are many and varied. Doctors all over the world are now making use of isotopes in the study of disease and of radio-activity for its cure; industrial chemists and physicists are creating new substances for our use. But perhaps the greatest change will come when atomic power can be made available in a practical form for the purposes of industry. Then we shall be no longer dependent for power, light, and heat on our rapidly shrinking deposits of coal and oil (see ATOMIC POWER, Vol. VIII).

See also MATTER; CHEMISTRY; ELECTRICITY.

AURORA BOREALIS. Also called the Northern Lights—a display of coloured light in the night sky of polar regions. In the southern hemisphere it is known as the Aurora Australis. During the long arctic winter, when for months on end the sun never lifts above the horizon, these lights make something of a substitute for daylight, and according to the accounts of those who have seen them there, often present a spectacle of magnificent beauty. The auroral light is occasionally seen in lower latitudes, and is fairly common in the extreme north of Scotland, but usually in far less brilliant colours. Though its form and appearance vary considerably on different occasions, it usually consists of a circular arch of white or greenish-white light stretching across the heavens and centred on the magnetic pole. This arch constantly flickers, brightening and dimming now in one place and now in another, so that it looks like lighted curtains being softly shaken. From the brighter parts long rays, often bright green, violet, purple, or rose, dart upwards and outwards, until they may even come together and meet overhead, to form what is called the 'boreal crown'—when half of the entire sky may be alive with light. The spectacle often lasts for several hours before it finally fades away (*see* Colour Plate opposite p. 32).

The underside of the auroral arch never comes lower than about 50 miles above the surface of the Earth, so that the phenomenon evidently takes place in that layer of the ATMOSPHERE (q.v.) which is called the 'ionosphere'. It has been found that outstanding displays of the aurora in the Arctic are always accompanied by simultaneous displays in the Antarctic, so that to observers on another planet the Earth at such times would appear to be glowing like a magnificent neon light. It seems that this kind of illuminant, familiar to us outside shops and cinemas, may be a very close parallel to auroral light, the probable explanation of which is given in ELECTRICITY IN NATURE.

As so often with extraordinary natural phenomena, superstitious beliefs are attached to the

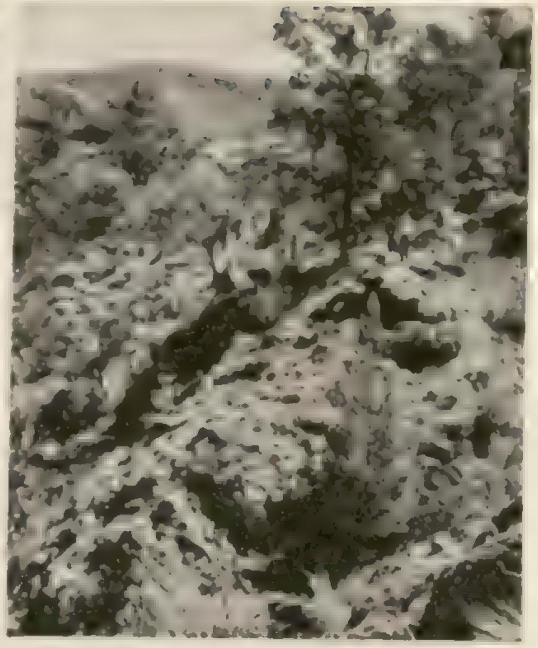
Aurora Borealis. Exceptional displays were supposed to herald war and other world disasters as the unusual display all over Europe in 1938, which was seen as far south as the Mediterranean, has no doubt been said to have done. Aurora was the Roman Goddess of Dawn. She was the daughter of the Sun-god, and it was her duty to lift the veil of night with her rosy fingers so it was natural that her name should have been associated with the brightly coloured polar lights.

AUSTRALASIA, *see* AUSTRALIA; NEW ZEALAND; PACIFIC ISLES.

AUSTRALIA. This is the only mainly English-speaking continent in the world, and yet it lies as far from England as it possibly could. A tunnel through the centre of the earth from London would come out near the Antipodes Islands, only 1,500 miles south-east of Australia. To the south there is a stormy ocean, and beyond that the ice of Antarctica. Eastward, America is 7,000 miles away. Africa is 6,000 miles to the west. To the north and north-west is Asia, and the islands of Indonesia are almost 2,000 miles distant. Yet Australia has had little contact with Asia. The first European colonists settled in the south-east, and to-day six-sevenths of the people of Australia live in the 'fertile crescent', a coastal strip 200 miles wide extending from Cairns to Port Pirie.

Australia is rather smaller than Europe, and about the same size as the United States of America. The Commonwealth of Australia includes Tasmania (26,215 square miles) and many smaller islands, and has an area of nearly two million square miles, more than a third of which is within the tropics. Though Australia has a much longer coastline on the Indian Ocean than on the Pacific, it is always called a Pacific Ocean country, and, indeed, it is the Pacific side that matters most.

There are three main types of country in Australia. Mountain ranges and table-lands, with small river-plains on the seaward side, extend down the east coast and curve round to Adelaide. Behind them the centre of the continent is filled by vast lowlands, broken by occasional mountain ridges. The western third is occupied by a low plateau of ancient rocks. The highest point, Mt. Kosciusko, 7,328 feet above sea-level, and all the peaks over 5,000 feet, rise in the eastern mountains. In contrast, the basin



MOUNT PAINTER, IN THE FLINDERS RANGE, SOUTH AUSTRALIA
The Times

of Lake Eyre in the central region is as low as 40 feet below sea-level. Except on the east and south-east coasts and in the south-west corner, Australia is arid, with low rainfall and high evaporation. In parts of the Lake Eyre basin the average rainfall is only 5 inches a year. West of the Gulf of Carpentaria in the north there is a wet monsoon season with heavy rains, and a dry season of 7 months with practically no rain. And so the rivers of Australia do not carry much water. The largest river system is that of the Murray in the south-east. The Murray and its tributaries drain 500,000 square miles, and supply the water for Australia's chief irrigated areas, notably the Murrumbidgee (Leeton) area in New South Wales, and Mildura in Victoria. Yet in the 1944–5 drought even the Murray carried no water to the sea for several months. Many rivers of the central lowlands which show up well on the map, such as the Finke, Diamantina, and Cooper's Creek, are rivers only after very heavy rain and then for but short periods. The majority of the lakes shown on maps of this region are dry most of the year, or are at best salt swamps. Lake Eyre, the largest, with an area of 4,500 square miles, is mostly salt mud, with water in only a few places.

ON AN AUSTRALIAN MERINO SHEEP STATION
Australian News and Information Bureau

It is not surprising, therefore, that about a third of Australia is either desert or fitted only for very thin grazing by stock, and that another third is suitable for grazing, but unlikely to have any considerable permanent population. Even the areas with fairly adequate rainfall have occasional but devastating droughts—such as that of 1944–5, when the wheat harvest was only about one-third of the normal amount.

Some parts of Australia, mostly in the east, have dense evergreen forests; but in general the most common plants are those which are equipped to resist drought. The characteristic forest tree is the eucalyptus, or gum-tree, of which there are 300 species. In Victoria and Tasmania these grow to well over 300 feet and challenge the sequoias of California for the title of the world's tallest trees. They yield a fine hardwood timber. Originally the eucalyptus grew only in the Australian region, except for one kind which was found in Mindanao in the southern Philippines. To-day they flourish in America, Asia, Africa, and southern Europe. In the dry regions dwarf Mallee gums, a few feet high, are scattered over vast areas. Australia has been widely separated from the rest of the world for so many millions of years that the bulk of its plant and animal life has developed along lines peculiar to itself.

Sheep, cattle, horses, and rabbits were all brought to Australia by Europeans. There are even wild camels, descended from camels which were brought from India to serve as beasts of burden in the desert. The original animals of Australia were nearly all MARSUPIALS (q.v. Vol. II), creatures, such as kangaroos and wallabies, that carry their young in pouches. Among them are the koalas or 'teddy-bears', which live up trees, eat only certain kinds of eucalyptus leaves, never drink, and have a most amiable appearance. The wombat lives underground and looks rather like a pig. Possums live in trees and can hang by their tails; and there are marsupial mice no larger than the European mouse. Tasmania has two carnivorous marsupials not found in Australia: the striped 'tiger', about the size of a wolf, and the smaller 'devil'.

Among the non-marsupial animals are the strange-looking PLATYPUS and ECHIDNA, which lay eggs and suckle their young. The Dingo, or

native dog, has now been largely exterminated owing to its habit of killing sheep. There are fifty kinds of mice and many bats, including the huge Flying-fox which eats fruit. Australian swans are black. The Emu is an ostrich-like bird. The wedge-tailed eagle, called the eagle-hawk, is the largest true eagle in the world. The kookaburra, or laughing jackass, is a giant kingfisher that avoids water, laughs like a maniac, and eats snakes. Other birds such as the BRUSH TURKEY, the LYRE BIRD (qq.v. Vol. II), and the Bower bird have interesting and unusual habits. Australia has many snakes, of which several varieties have poison-fangs, but few are dangerous to man.

There are not many wild fruits which can be eaten, except for the exocarpus—a native cherry which has its stone outside. In addition to this, the AUSTRALIAN ABORIGINES (q.v. Vol. I) made use of roots and the seeds of grasses and other plants for their food. European settlers imported grains, fruits, and root crops, and introduced new grasses. But sheep-farming, Australia's greatest industry, still depends mainly on grazing the native grasses and bushes, such as the curious blue saltbush which grows in the dry country.

The early settlers in New South Wales lived largely on maize. Wheat is now the chief grain crop, and varieties have been found which can grow with little more than 10 inches of rain a year. Potatoes grow best in Tasmania, Victoria, and the table-lands of New South Wales. Sugar-cane is grown in tropical Queensland, where it thrives in the rich alluvial soil and heavy rainfall of the coastal areas. Apples, pears, and plums do best in the cooler regions of the mainland and in Tasmania, which is sometimes called the Apple Island. Grapes are important, especially in the irrigated area of the Murray

AUSTRALIA

basin, such as at Mildura, where there is water from the river, and a rainless period of hot sunshine serves to dry them and turn them into raisins and currants. Rice is grown in the Murrumbidgee irrigation area.

Australia is rich in minerals. There are deposits of black coal in New South Wales and vast deposits of brown coal in Victoria, used mainly to develop electric power. Western Australia is an important gold area, and there is much gold in Bulolo in the New Guinea territory, which is held by Australia under mandate. Machinery and supplies—including even cows—have been taken there by air.

In the arid region west of Spencer Gulf the extremely rich iron ore of the Iron Mountains supplies the raw material for the steel industry of New South Wales—and, more recently, for an iron-working and shipbuilding town created at Whyalla, near the ore-beds. Coal is brought from New South Wales. In the tropical north-west, rich iron ore is quarried from islands in Yampi Sound and transported to Newcastle in New South Wales. Broken Hill, in the arid south-west corner of New South Wales, holds one of the greatest deposits of silver, lead, and zinc in the world. Australia is also a large producer of copper.

There has been much argument as to the number of people Australia is capable of supporting. The official aim of the Commonwealth Government is twenty millions, some thirteen millions more than there now are. This seems a modest figure, and may very well prove to be an under-estimate.

See also ADELAIDE; BRISBANE; CANBERRA; HOBART; MELBOURNE; PERTH; SYDNEY.
See also Vol. I: AUSTRALIANS.

AUSTRIA. Modern Austria is a small country of about 32,000 square miles, slightly larger than Scotland, with some six to seven million people. Since 1919, when it lost its only seaport, Trieste, it has been an inland country (*see* Map, p. 160). Most of it is mountainous, some two-thirds being over 3,000 feet above sea-level. More than a third is forest, and a tenth is barren rock and glacier. Because of these natural factors, the Austrian people are very unevenly distributed—indeed, some two millions, or a third of all Austrians, live in the capital city of VIENNA (q.v.), which owes its size to the fact that it used to be the centre of the great Hapsburg Empire.

Though small and poor in natural resour[ces,] the central position of Austria in Europe, a[nd] the fact that it is crossed by the River DAN[UBE] (q.v.), make it important economically, str[ate]gically, and politically. Austria is essential[ly a] junction where north and south, east and w[est] meet, as is shown by its many different kind[s of] landscape and climate, its plants and wild l[ife,] as well as by its mixture of races and cultu[res.]

The eastern end of the ALPS (q.v.), which [are] separated by the Danube from the Bohem[ian] Mountains, occupy the greater part of Aust[ria.] The Austrian Alps, though lower than the Sw[iss] Alps, none the less have some of the grand[est] mountain scenery in all Europe. In Carinth[ia,] for instance, in which the highest peak rises to 12,500 feet, there are some 200 lakes. Ap[art]

ALPBACH, A VILLAGE IN THE AUSTRIAN ALPS
Paul Popper

from their magnificent scenery, these mountains are important for the timber which grows on their lower slopes, for the Alpine pasture on which the dairy-cattle feed, and for the electricity generated by their water-power. Salt is mined near Salzburg, and there are coal and lignite mines in the central region.

The Danube runs through wooded hilly country, where the climate is milder and the soil

more fertile than in the alpine regions. There are vineyards and many old historic mansions, castles and monasteries, often of great architectural beauty. The valley opens out eastward into the Vienna Basin, a depression about miles long from north-east to south-west, and about 20 miles wide. Here routes from north, south, east, and west converge. The land is intensively cultivated, though many areas bordering the Danube are liable to flooding. The main crops are wheat, sugar-beet, and vines.

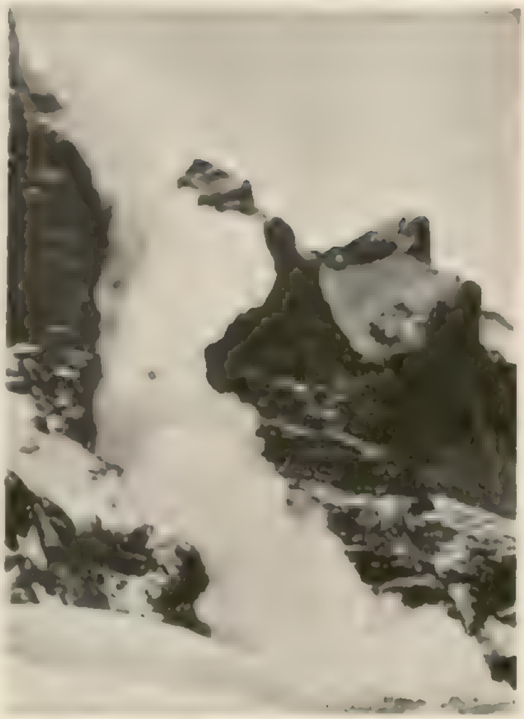
See also Vol. I: Austrians.

AVALANCHE. An avalanche occurs when a mass of material on a mountain-side begins to slip and finally hurtles down. There are avalanches of earth, stones, rock, ice, and snow; but usually the word is used to describe an avalanche of snow, and it is snow-avalanches that are described here.

Snow lies and builds up to great thickness on some steep slopes, especially if the surface of the slope is not very smooth. As a general rule it is assumed that snow lying on a clear slope steeper than 22° is liable to avalanche. When a snow mass is so poised, a very small disturbance may set it in motion: the vibration of a passing train, the movement of a man or animal, the fall of a tree branch, or even a sound, can cause thousands of tons of snow to come crashing down a mountain-side.

The speed of an avalanche varies considerably: some move no faster than about 20 m.p.h., while others have been estimated to have a speed of about 200 m.p.h.

The snow involved in a big avalanche may amount to over a million cubic yards and weigh thousands of tons. Such a mass hurtles down the mountain-side with a roar like thunder and sweeps away or crushes objects that lie in its path. However, the most frequent, and often the most powerful, instrument of destruction is not the snow but the wind caused by the avalanche. The swiftly moving mass of snow pushes the air in front of it with such violence that it fans out sideways as well as driving directly ahead. This wind sometimes reaches a force almost equal to that of a tornado, and is responsible for most of the fantastic effects of avalanches. Once, thirty small buildings were seen to disintegrate under the impact of the wind-blast from an avalanche which came to rest 200 yards



AN AVALANCHE ON THE WETTERHORN, SWITZERLAND

E.N.A.

away; and during another avalanche, trees 1,500 feet ahead of the advancing mass of snow were thrown down. A very spectacular incident was that in which a large section of an iron bridge, weighing several tons, was thrown about 150 feet upwards. Perhaps the greatest known destruction of an avalanche wind happened in 1819 in the Alps, when part of a glacier slid downhill and over a precipice: the resulting wind scattered and almost totally destroyed the houses in the nearby village of Randa, flung the steeple of the stone church to the ground, and tossed heavy millstones about like leaves in a gale.

Luckily, as most avalanches occur in uninhabited parts, the damage they do is small compared to that done by tornadoes, hurricanes, and earthquakes. In settled areas measures are taken to prevent large avalanches—trees are planted fairly close together, and rows of strong walls are built so that large snow masses cannot form. Another method used is to shoot at and so dislodge small avalanches before they can grow big and dangerous.

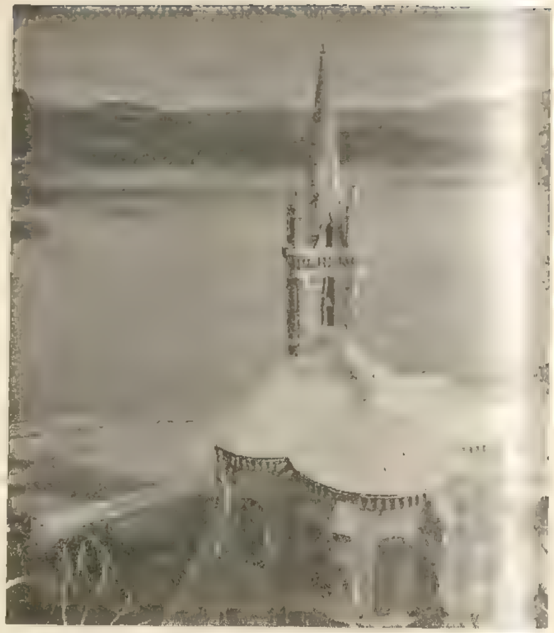
AZERBAIJAN. The Soviet Socialist Republic of Azerbaijan, together with the Soviet Socialist Republics of GEORGIA and ARMENIA (qq.v.), forms Transcaucasia. Azerbaijan lies on the west coast of the CASPIAN SEA (q.v.), east of Armenia and south-east of Georgia.

Azerbaijan consists of the broad valley of the lower River Kura, the slopes of the CAUCASUS MOUNTAINS (q.v.) in the north, part of the Armenian Highlands in the south-west, and a narrow coastal plain along the Caspian Sea. The Kura valley is dry and arid, with cool winters and very hot summers. Nearly all the cultivation is near the banks of the river and of its tributaries, where the land can be irrigated. Azerbaijan is one of the main cotton-growing areas of the U.S.S.R. Tobacco and vines are also cultivated. In the valleys of the Caucasus and of the Armenian Highlands there is more rainfall, so that cattle can be kept and cheese and butter produced. The Caspian coastal plain has a sub-tropical climate, with warm wet winters and hot dry summers. Thick forests cover the slopes of the hills, and on the lowlands lemons, oranges, tea, and tobacco are cultivated.

The chief oil-fields of the U.S.S.R. lie in the Apsheron peninsula of Azerbaijan, to the east and south of Baku, near the mouths of the River Kura. Baku, the capital, is an ancient city, a centre of caravan trade in the past, with an old Arabic fort and palace; to-day it has modern buildings and colleges. There are now large oil refineries to deal with the oil from the wells of the Baku oil-fields, before it is shipped by the Caspian Sea and the River Volga to other areas of the U.S.S.R., or is pumped by pipe-line to Batum on the Black Sea. Industries making equipment for the oil industry have grown up, as well as cotton-mills to manufacture the raw cotton from the Kura valley.

See also U.S.S.R.
See also Vol. I: RUSSIANS.

AZORES. About 900 miles west of Portugal, on roughly the same latitude as Lisbon, lies a group of islands called the Azores. Rocky and of bold relief, they are of volcanic origin, and rest on a great ridge called the Dolphin Ridge (*see* OCEANS), which rises from the bed of the Atlantic. The Azores belong to Portugal, and to that country most of their produce is sent. There are ten islands set out in three groups, the largest island being San Miguel, which is 41 miles long and 9½ miles wide. Ponta Delgada is the chief town of San Miguel. Ships call at Fayal Island, where there is a good harbour at Horta. Pico, in the central group, contains the highest mountain, Gran Pico, which rises to 7,600 feet above sea-level. This peak is composed of volcanic rocks, and small eruptions still disturb the area. Flores is the island where Sir Richard Grenville and his fleet took shelter before attacking the Spanish fleet. Tennyson, in his poem *The Revenge*, gives an account of this sea-battle.



SAN MIGUEL, AZORES
Royal Geographical Society

Over 30 inches of rain fall on the islands during the year, most of it in winter. Agricultural products are tobacco, apples, grain, oranges, pineapples, and wine. Adequate rainfall nourishes grass for herds of dairy cattle, and good butter and cheese are produced. The population of the Azores is 232,000, almost all of whom are engaged in farming or in dealing with the products of the land.

B

BAFFIN LAND, *see* GREENLAND.

BAGHDAD. For centuries the name Baghdad, the capital of Iraq, has conjured up in the minds of western peoples all the colour and glamour of the *Arabian Nights*, the richness and mystery of the East. To-day the city is a curiously confused mixture of old and new, rather disappointing to the western visitor, except for small parts. Sheikhs from the desert still come on pilgrimage—but more often by motor than by camel; and bearded, robed Iraqi and traditionally garbed Jews do their shopping more often in shops of European design, stocked with European goods, than in the bazaars of the Arab quarter.

ON THE BANKS OF THE TIGRIS AT BAGHDAD

The historic Baghdad, capital of the Caliphs, was on the west bank of the Tigris; modern Baghdad, capital of the young country of Iraq, lies along 2 miles of the east bank of the river. It is a tightly packed area of warehouses, offices, mosques, and residences, some three-quarters of a mile deep; yet seen either from the river or from the railway which follows its west bank, the city looks quite picturesque, with the domes of its many mosques rising among the big buildings, and the lively river scene. The river is generally crowded with native boats, some piled high with fruit and other merchandise, and others loaded up with passengers or with animals.

Most of the buildings are of mud bricks, and many of them are in a poor state of repair, so that the narrow winding streets look squalid and gloomy. The only broad thoroughfare, New Street, runs from the south gate of the old city walls, roughly parallel to the river but at some distance from it, to the north gate. The wealthy quarter of the town is near the south gate, and here there are old Arab houses with high walls, courtyards, and terraces.

Farther north, between New Street and the river, there are the bazaars—a maze of lanes and arcades crowded with merchants selling carpets, gem-stones, silks, and perfumes, with silversmiths, leather-workers, and other craftsmen. To the east of New Street the lanes are wider and very attractive with their broad-eaved houses and overhanging windows.

See also IRAQ.
See also Vol. I: IRAQI; ARABS.

BAHAMAS, *see* WEST INDIES.

BALEARIC ISLANDS. This flourishing little group of islands lies in an arc in the western Mediterranean Sea between Spain, to which they belong, and Sardinia (*see* Map, p. 160). Majorca (Mallorca) is the largest; to the east is Minorca, the second largest. Iviza and Formentara, to the south-west, are sometimes called, along with four smaller islets, the Pityusae or Pine Islands.

The climate of all the islands is pleasant, though that of Majorca is best, for the highlands which border its north-west coast protect it from northerly winds. Minorca is unprotected from the north and occasionally gets cold winds, while

AN OLD WELL IN POLLENSA, MAJORCA
Dr. W. D. Hogarth

Iviza suffers sometimes from the hot desert wind, the SIROCCO (q.v.).

Olive-groves and vineyards flourish on the coastal plains. Almonds are grown, as well as vegetables, oranges, and figs. Iviza specializes in apricots; Minorca exports honey and cheese; Formentara produces fine corn crops; pigs and poultry are reared everywhere, and the pines from the hill-sides supply a well-established timber industry. Lobsters are sold in large quantities to Spain. Pottery and glazing are old crafts, and the majolica ware of the islands is famous. Boot and shoe making is an important new industry.

The Moors left many evidences of their dominion over the islands in the Middle Ages. Palma, the capital of Majorca, is very Moorish with its squares and courtyards, its flat-roofed houses with barred windows, and its wells. In the 18th century Minorca was British, and the houses of the capital, Port Mahon, show influences of the British architecture of that time.

BALTIC SEA. This almost inland sea opens into the North Sea by narrow channels between Denmark and Sweden, called the Great and Little Belts, and then through the Kattegat and the Skagerrak (*see* Map, p. 160). At its extreme north is the Gulf of Bothnia, and eastwards ar the narrow Gulf of Finland and the smaller Gu of Riga. The Baltic is now joined to the Whi Sea and the Arctic by the White Sea Cana which runs from the head of the Gulf of Finlan through Lakes Ladoga and Onega. The canal 142 miles long and was opened in 1933. In t south-west the KIEL CANAL (q.v. Vol. IV), bu by Germany in 1895 for strategic reasons, pr vides an additional exit to the North Sea.

The Baltic is surrounded by Sweden, De mark, Germany, the Baltic Republics of tl U.S.S.R., and by Finland. Many great rive such as the Oder and Vistula, flow into it, an in consequence it is less salt than the ocean. It a shallow sea, with an average depth of 2 fathoms (120 feet), and in many places san banks and shoals make navigation difficult a dangerous. Large areas of the sea and sever of its ports freeze up in winter. It has mar islands, of which Gottland and Oland (Sweder and the Aland Islands (Finland) are among tl largest. The southern shores are notable f the sand-spits and dunes, called *nehrungs*, whi have been formed by wind and currents acr the mouths of the main river inlets.

At the close of the ICE AGE (q.v.) the Bal was much larger than it is to-day. It cover the central lake-belt of Sweden, extended ea wards into Russia, and was joined to the Nor Sea by a broad channel. Geologists call this tl Yoldia Sea. Later, the level of the land surfa rose and closed the channel to the North Sea, transforming the Yoldia Sea into a fresh-water lake called Ancylus. Geologists have discovered this by studying the salt or fresh-water plant and animal remains found on the sea-bed. The shape of the Baltic as it is to-day is due to the subsequent formation of the present narrow straits connecting with the North Sea.

In the days of sailing-ships the Baltic Lands were important suppliers of ropes, sail-cloth, and timber. During the late Middle Ages this trade was controlled by the free cities of the HANSEATIC LEAGUE (q.v. Vol. VII), which included Baltic ports such as Lübeck, Stettin, and Danzig. Some of these ports have lost their former importance, but the Baltic is still a highway for trade, particularly between the countries which surround it.

BANGKOK. The capital and chief port of Siam is situated on the River Menam, some

A CANAL IN BANGKOK
B.O.A.C.

miles above the Gulf of Siam. It is a picturesque city, with flimsy wooden houses, thatched or tin-roofed, which jostle each other along the river-banks—indeed many houses are actually built out over the river on stilts or on floating pontoons, and many people live in houseboats moored along the river. The city is criss-crossed by a network of canals and creeks, on which ply numerous native boats called *prahus*. These are propelled by one oar at the stern, and many have a tent-like cabin made of woven matting for protection against the tropical sun and rains. The hot and damp climate favours the growth of trees, which line the canals, and often meet overhead to form a dark tunnel through which the boats glide silently. For many years the canals were the streets of Bangkok, and so it has been called 'the Eastern Venice'. Nowadays, however, roads have been built to allow easier movement within the city.

Bangkok is a long narrow city, extending for about 10 miles up the river, but only about a mile wide. The buildings and vegetation are so dense that it takes a considerable time to get through some parts of the city. There are some modern concrete buildings in the middle of this native eastern town—commercial houses, an up-to-date hospital, shops, and a University, for instance. In fact, modern Bangkok is a fashionable city, with a gay cosmopolitan life. It is difficult to know how many people live in Bangkok; but a recent estimate suggests a population of 700,000 at least.

Bangkok possesses many old Buddhist temples, called *wats*. With their steep ornamented roofs and spires, their images and tinkling bells, these are most impressive to the stranger. The Wat Po, one of the largest temples, is enclosed by a high wall, in which are several gateways with huge statues of carved stone standing by them to protect the entrances. Inside the temple is a recumbent figure of Buddha, 170 feet long, and covered with gold leaf.

The industries of Bangkok are rice-milling and boat-building, and there are many sawmills where logs of teak, which are floated down the river to the city, are cut up into planks for export.

BARBADOS, *see* West Indies.

BAROMETER, *see* Pressure.

BASALT, *see* Rocks, Section 2 (*a*); Earth.

BAVARIA, *see* Germany.

BELFAST. The capital of Northern Ireland lies at the end of Belfast Lough, a great inlet of sea running between the counties of Down and Antrim in north-east Ireland. It was little more than a fishing village in the 16th century, when it was the headquarters of one of the branches of the House of O'Neill, and was the scene of much bitter fighting between the O'Neills and the English. By the 17th century it had already become a port of consequence. A hundred years later it had 9,000 inhabitants, and by 1937 nearly 450,000. As it did not become a large city till the 19th century, Belfast has not many buildings of historical interest.

After the separation of the Six Counties of Ulster from the rest of Ireland in 1922, Belfast became the capital of Northern Ireland and seat of the Northern Irish Government. The members of the Northern Ireland Senate and House of Commons meet in an immense Parliament Building outside the town.

For years Belfast's chief industry was linen-making. This is still a very valuable trade; but the city's main importance is now as a port and centre of shipbuilding—before the Second World War it was fifth in size among British seaports. It has one of the largest graving-docks in the world, and in Harland and Wolff's shipyards many great liners have been built, including the ill-fated Titanic.

BELGIAN CONGO. This vast country of western Equatorial Africa has an area of nearly 910,000 square miles, to which should be added the mandated Ruanda-Urundi territory of 25,500 square miles which lies beyond the Rift Valley on the east. A corridor less than 100 miles wide, between French Equatorial Africa and Angola, runs westward, narrowing at the Congo mouth to give the Belgian Congo one very narrow outlet to the sea—an Atlantic coastline about 12 miles long (*see* Map, p. 5).

This part of Africa was not explored by Europeans until towards the end of the 19th century. The Portuguese in 1482 had discovered the mouth of the great Congo River, but Stanley (q.v. Vol. V) was the first European to trace the whole course of the river. The King of the Belgains became interested in Stanley's discoveries, and formed a company to gain control of the area, and to set up the Congo Free State, of which he became king. But the state was inefficiently administered and the natives treated so badly that in 1908 the Belgian Government took over the Congo and reorganized it thoroughly. Now it is a well-administered and very wealthy Belgian colony, with a native population of over ten millions. Apart from the Pygmies (q.v. Vol. I) of the tropical forest, the natives are Bantu-speaking Africans (*see* Negro Africans, Vol. I).

The most important physical feature of the Belgian Congo is the great Congo River (q.v.). This river rises in the highlands, south of Lake Tanganyika, in the south-east of the Belgian Congo, and it and its many tributaries, some of them very large rivers, drain almost the whole area of the country. In its lower reaches the river flows through vast equatorial forest, hot and steamy and with very dense vegetation. The country on each side of the middle Congo, as far as the Stanley Falls, is mainly swamp, flooded twice a year when the heavy rains come.

Much of the Belgian Congo is high, hilly country. In the east, the mountain range of Ruwenzori rises to 16,815 feet above sea-level. Large areas, north and south of the forest, are tropical grasslands called savannas (*see* Grasslands, Section 2), and above these are hilly, wooded plateaux, where the cattle-keeping people live. The eastern frontier cuts through the great lakes of Mweru, Tanganyika, Edward, and Albert, in the Rift Valley.

The Belgian Congo is very rich in raw materials of many kinds, the possibilities of which are still not fully exploited. There is great mineral wealth. As well as gold and diamonds, tin, zinc, manganese, cobalt, cadmium, and tungsten, there are some of the largest copper deposits in the world. The main mining district is in the Katanga Highlands in the south-west of the country, and Elizabethville is the centre of the copper-smelting industry. Uranium, from which a very large proportion of the world's radium is refined, was discovered in 1913.

Europeans first came to this country in search of wild rubber. Such wasteful methods were used at first that the industry was nearly destroyed; but now properly managed rubber plantations have been established, and better rubber is being produced. Coffee, cacao, sugar-cane, maize, and other plantations flourish, and

A VILLAGE IN THE EQUATORIAL FOREST OF THE BELGIAN CONGO

Service de l'Information, Belgian Colonial Office

there are considerable cotton plantations in the south, much of the raw cotton being spun and woven in the mills at Leopoldville, the capital. Palm-oil, used by the natives instead of butter, is exported to Marseilles and other cities to make margarine and soap. There is great wealth of timber in the forests, and a variety of valuable hardwoods is exported. But it is no easy task to extricate the timber from the dense forests, where the rivers are almost the only openings.

The women are the main agriculturists, and also they make simple pottery, which they dry in the sun and harden in a fire. The men hunt and fish, and weave raffia into cloth and canes into baskets and fish traps. Their wood-work includes dug-out canoes, signalling-drums, paddles, stools, and grotesque wooden masks. They also work in iron, brass, and copper.

The immense size of the country and the great variation in height above sea-level result in a wide variety of plant and animal life. In the Congo forests are found a full range of tropical plants (*see* Tropical Jungles, Vol. II) and animals, such as hippopotami, gorillas, many kinds of snakes and tropical birds. In the savannas are the open grassland animals, such as antelope, deer, and zebras, as well as a few lions and leopards and an occasional elephant.

BELGIUM. Belgium and Holland together are often called the Low Countries. Belgium, however, has no land actually below sea-level; in the south, in fact, the ancient rocks of the Ardennes form a rugged upland with peaks rising to 2,000 feet. For the most part, the country forms part of the North European Plain.

THE FLAT FARMLAND OF NORTH BELGIUM. *E.N.A.*

Most Belgian rivers flow in a north-easterly direction towards the Rhine; but the most important, the Schelde, enters the sea by a separate estuary inside Holland. The Meuse, which rises in France, cuts a deep, narrow valley through the Ardennes, and then emerges on to the plain, where it is joined by a tributary, the Sambre; it then skirts the foot of the mountains and turns north into Holland to join the Rhine. The Sambre–Meuse valley has always been an important route linking Paris with the Rhine. Other navigable rivers are few; but in such level country rail and canal communications are easily made, and, in fact, all over Belgium most heavy and bulky goods are transported by canal.

The coast of Belgium is very smooth, with broad sandy beaches backed by dunes. It is, therefore, a popular holiday area. Ostend and Zeebrugge, besides being holiday resorts, are busy ports; but their harbours are artificial and require constant dredging. Zeebrugge (or Bruges-on-Sea) is linked by canal with Bruges, once the chief European centre for cloth-weaving, and itself a busy port in the Middle Ages. When the marshes round the Schelde estuary and the Rhine were drained, the old western ports, such as Bruges and Ghent, decayed. Antwerp, at the mouth of the Schelde, is now the chief port. Here arrives rubber from the BELGIAN CONGO (q.v.), as well as the materials for the textile factories; and her shipped for export the manufactured goods the coal-field towns. Antwerp has also imp industries. BRUSSELS (q.v.), the capital of gium, is situated midway between the p Antwerp and the coal-field to the south.

The main Belgian coal-field lies along Sambre–Meuse valley at the foot of the Ard uplands and stretches into both France Germany. Here a line of manufacturing t including Mons, Charleroi, Namur, and L has sprung up, the most important Liège. The Albert Canal, opened in 1939, Liège with Antwerp.

The soils of Belgium are mainly poor, up of dry sands and clays. However, they been very intensively cultivated; and wh sugar-beet, hops, tobacco, and flax are gr while many cattle are reared. In the ea narrow belt of rich loam soils, similar to 'polder' lands of Holland, is mainly devot intensive fruit-farming and market-garden The flax is 'retted' (or soaked to prepar for manufacture) in the waters of the Sch Lys, and other streams, and is made linen at Courtrai, Tournai, and Ghent.

THE MINNEWATER, BRUGES

The river flows beside the medieval walls of the city

Paul Popper

combination of intensive agriculture with mining and manufacturing is largely responsible for the fact that Belgium, with a population of between eight and nine millions, is one of the most densely peopled countries in Europe.

The only really thinly peopled area is that of the Ardennes in the south, where the land is high, the soil infertile, and the climate more extreme. Much of this highland is heavily wooded. Apart from a little iron- and copper-working, the only occupation is a rather poor farming.

See also Vol. I: Belgians.

BELGRADE (The White City). The capital of Yugoslavia occupies a hilly promontory overlooking the point where the River Danube (q.v.) is joined by its great tributary the Sava. All around stretches flat monotonous plain, marshy near the river-side, and liable to flooding in the spring. Because of this, Belgrade, high up on its ridge, has great strategic importance, and since Roman times has been a natural stronghold whose possession has been fiercely contested. It has belonged at various times to the Huns and Goths, the Byzantine Empire, the Hungarians, and Austrians. In 1521 it was captured by the Turks, who built a citadel on the highest point of the promontory to guard the junction of the two rivers. In 1866 Belgrade was recaptured by the Serbs. Then, after the First World War, when the Southern Slavs were united into one kingdom, Belgrade became the capital.

It is not surprising that not many old buildings have survived the city's stormy history. The old Turkish Citadel is still to be seen, and there are a few picturesque old houses, white-walled and red-roofed. The modern town has few interesting buildings. Much of the character of the city comes from its inhabitants. In the market, for instance, the women can be seen wearing bright-coloured head-kerchiefs, and the men white baggy trousers, white coats, and black Astrakhan caps. A great variety of fruit and vegetables fills the markets themselves with colour.

Modern Belgrade consists of an upper and lower town. From the upper town, which clusters round the old fortress, there are fine views of the Danube and the plain of Hungary beyond. The main street runs along the summit of the ridge, and steep side-roads, often thick with mud or slippery with ice and snow, lead up to it from the water's edge. Since Belgrade has become the capital of a new, ambitious country, many modern administrative and commercial buildings have sprung up. As these are mostly built of white stone, Belgrade more than ever deserves its name 'the white city'.

The lower town is a busy river port on the Danube, second in importance only to Vienna. Belgrade, though not itself a great manufacturing town, is an important trading centre, and its wharves and railway-sidings handle a great amount of traffic. Its population is about 250,000.

See also Yugoslavia.

BERLIN, which has been the capital of Germany since 1871, was founded in the 13th century as a fishermen's settlement on an islet in the River Spree. In the 15th century this grew into a town which became the residence of the Electors of Brandenburg. By the 18th century Berlin had become the commercial and military capital of Prussia, as well as a centre of culture and of the German romantic movement. But Berlin is essentially a 19th-century city, and it was during the 19th century that it became the third largest city in the world.

During this period trade and industry developed vigorously throughout Germany. Berlin's inner district grew up into a city, and the outer districts turned into large satellite towns. As prosperity increased, these towns were incorporated as residential suburbs, and beyond them again grew up big industrial establishments with houses for the workers around them. In the 1930's the area of Greater Berlin was larger than that of London or New York, and had a population of over four millions. The city had crept gradually nearer to the flat but very attractive country-side of Brandenburg, with its many lakes, rivers, and woods. The description which follows refers to Berlin as it was before the terrible destruction of the Second World War fell upon it.

Because the city developed rapidly without the control of sound planning, some of the modern parts show a rather irregular character; yet there is a more representative quarter, with a layout of traditional dignity and a certain architectural beauty, grouped around a sequence of streets going westward from the centre of the town (Alexanderplatz). The most remarkable part of this is the avenue called 'Unter den Linden' (under the lime-trees),

which runs from the Royal Palace and the very imposing late 19th century cathedral to the great Brandenburg Gate and the Tiergarten (zoological gardens), Berlin's Hyde Park. This famous street contains the University, the State library, and the Opera House, and the most important palaces, museums, and hotels. Westwards it runs to the Königsplatz (King's Place) where stands the Reichstag or Parliament House. In nearby streets and squares, such as Wilhelmstrasse, the equivalent of Whitehall, are the main government buildings, and centres of banking and big business.

The visitor to Berlin used to get a general impression of showiness, of big size, and of efficiency. The tall blocks of flats were richly plastered, ornamented, and stuccoed, the streets wide and well cared for, the traffic, though noisy, excellently organized. But the visitor was apt to feel that this proficiency lacked tradition and taste. Though this may have been true, Berlin had achieved much in the spheres of social welfare and public hygiene. The world of theatre, music, art, and advanced education was at a high standard. Her enormous industrial plants, the power-station 'Kraftwerk Klingenberg', or the imposing Spree harbour 'Westhafen', were truly admirable, and she could show many of the best examples of modern functional architecture.

BERMUDAS. This is a group of small CORAL ISLANDS (q.v.), belonging to Britain, which lie in the Atlantic, 580 miles east of North Carolina (*see* Map, p. 322). There are about 1[illegible] islands and many more islets, but only some 20 are inhabited. They derive their name from Bermudez, a Spaniard, who sighted them in 1527; but they were first colonized by Admiral Sir George Somers, who was shipwrecked there in 1609 on his way to Virginia. There is now a population of over 12,000 white and about 20,000 coloured people. The Bermudas have the oldest colonial representative government in the British Empire.

A mild, healthy climate and beautiful scenery make the Bermudas a favourite holiday resort, especially for Americans. Market-gardening is the chief occupation, and early vegetables and flowers, especially lilies, are exported, mainly by air to America and Canada. The most common tree is the so-called Bermuda cedar, a heavily scented juniper, the timber of which is used for small vessels. Orange, lemon, and lime-trees grow wild on the islands.

THE NARROWS, BERMUDAS
Paul Popper

AN OLD STREET IN BERN
Swiss Federal Railways

N. The capital of Switzerland is not as nt as many European capitals. It dates he very end of the 12th century, and most finest buildings belong to the 14th and enturies. It has been capital of the fede- l states of Switzerland for over 100 years. Federal Council and Assembly meet in the modern Federal Palace overlooking the er Aar. This is also the headquarters of ral international organizations, including International Postal Union.

Bern is situated on the Swiss plateau near that part of the Alps known as the Bernese Oberland. From the old walls of the city there are magnificent views of the mountains. The old town is surrounded on three sides by the River Aar and is connected by bridges with the new town. In the old town many of the streets are lined by deep arcades into which the sun never reaches, and behind these are the town houses of the Bernese nobility. Among the finest buildings of Bern are the 15th-century Rathaus (Town Hall), the late Gothic Cathedral, and the old Clock Tower, originally the west gate, but now almost in the centre of the city. Its curious 16th-century clock has a procession of wooden bears and other puppets which march round a figure of Father Time just before the hour—which is announced by the crowing of a cock. Bern's 'patron animal' is the bear, and on the east side of the town the old bear-pit has for centuries contained live bears which beg for buns. There are pictorial bears on the city arms, shop-signs, and fountains; and several streets and squares, as well as the town itself, are called after bears.

Bern is a great railway junction for routes to France, Italy, and Germany. It is also an industrial city, important for its manufacture of watches, clocks, musical-boxes, textiles, and chocolate. Its population is about 150,000.

See also SWITZERLAND.

BERYL, *see* AQUAMARINE; EMERALD.

BIRMINGHAM. With a population of over 1,100,000, Birmingham is the second largest town in Great Britain. It lies almost at the centre of England, about 100 miles north-west of London, and is often called 'The Capital of the Midlands'. It is also the world's centre for hardware and small metal goods. Guns, motor-cars, aero-engines, bicycles, machinery, toys, nibs, every description of ironmongery and hardware, of japanned, plated, and enamelled goods, buttons, ornaments, and jewellery—Birmingham makes them all and has probably led the world in their manufacture. The character of Birmingham people is, above all, independent and energetic, as their history bears out.

The first mention of Birmingham is made in Domesday Book, when it was a small manor. In 1166 it was granted the right to hold a market. Tanning seems to have been the first industry. By 1538 the town was already supported by its blacksmiths, using coal and iron from Staffordshire. As might be expected, Birmingham supported Parliament against the King in the Civil War, and was largely destroyed by Prince Rupert in consequence. In the 17th century there was a period of religious persecution of Nonconformists, and in 1665 an Act called the Five Mile Act forbade ministers of any denomination except the Church of England to live within 5 miles of any corporate town. Birmingham, although a large town, had not yet received its right to have a 'corporation' (i.e. a body to run its own affairs). A large number of Dissenters, therefore, men above all of independent minds, including many QUAKERS (q.v. Vol. I), came to settle in Birmingham, which offered them the advantages of a large town without its political drawbacks. These people and their descendants became important citizens, and kept alive in Birmingham a liberal-minded

and independent policy; and, in consequence, the city has been to the fore in many movements of social and municipal reform, including housing and town planning. In 1875, when Joseph Chamberlain was Mayor, a policy of vigorous municipal reform started.

To-day, although there are still some slums, Birmingham compares well with any industrial city in the kingdom for housing (Bournville, founded by the Cadbury family in 1879, gave a lead in the Garden City Movement (q.v. Vol. X)) and municipal undertakings generally. The city now has an excellent University. It is well served by road, canal, and railway. To the south-west, where the Lickey Hills form a beautiful public reservation of many acres, the country still comes near the heart of the city. The residential suburb of Edgbaston still retains many trees and large old-fashioned gardens.

BITUMEN, *see* Asphalt.

BLACK SEA. This sea lies south of the U.S.S.R. and north of Turkey. Mountains border it to west, south, and east; to the north are plains. The southern part of the sea is deep and very salt, whereas the northern part, divided by the peninsula of the Crimea into the Bay of Karkinit and the Sea of Azov, is shallow and brackish. The only outlet of the Black Sea is at its south-western corner. There the surface

THE BLACK SEA

waters pour through the narrow Bosporus Strait past the great city of Istanbul (q.v.) into the Sea of Marmara, and then through the Dardanelles into the Mediterranean. These surface waters are not very salt; but beneath them, and going in the opposite direction, there is a much smaller flow of very salt water. This very salt water collects in the deep southern half of the Black Sea, where the greatest depth is more than 1,200 fathoms, and lies in a huge pool beneath about 50 fathoms of surface water. It is almost stagnant and has not enough oxygen to support plants or fishes.

Five great rivers flow into the northern part of the Black Sea. The Danube, the Dniester, the Bug, and the Dnieper flow into the Bay of Karkinit, while the Don flows into the Sea of

THE BOSPORUS. *Dorien Leigh*

...ay, which is connected to the southern part ...the narrow Kerch Strait. The waters of these ...ers make the northern part much less salt than ... southern, and as it is also shallow it very ...en freezes. Unlike Odessa and other ports of ... U.S.S.R., which have to be kept open by ...-breaker, the harbour of Sevastopol (Sebas...ol) at the southern tip of the Crimea ...insula never freezes. This has led to its ...oming an important naval base.

...he Bosporus and the Dardanelles are also ...y important, as they give direct access by sea...ng ships to the ports of southern U.S.S.R. and ...the great waterway of the Danube. This ...ans that the grain of the Danube valley and ...the rich black-earth belt of the Ukraine, the ...l and manufactures of the Donbas, and the ...piped across from Baku, on the Caspian Sea, ...he Black Sea port of Batum, can be exported.

...IZZARD, *see* SNOW.

...G, *see* MARSH AND MOORLAND.

...HEMIA, *see* CZECHOSLOVAKIA.

...KHARA, *see* UZBEKISKAYA.

...LIVIA. Formerly this South American ...ublic extended to the Pacific Ocean; but by ...ries of treaties and conventions its territory ... reduced by about a quarter, and it is now ... of the two South American Republics with ...outlet to the sea—Paraguay being the other ...Map, p. 415). It is the most sparsely popu...d of all the republics, having but four people ...the square mile, and a total population of ...ly about 3½ millions.

There are two main types of country, the mountainous or high Andean region, and the tropical lowlands. In the west are the high ranges of the Andes Mountains, with two peaks over 21,000 feet high, and the plateau, 12,000 feet high, where over half the population live. This plateau is monotonous, inhospitable country. At its northern end, nearly 13,000 feet above sea-level, is the high mountain lake, Lake Titicaca. Across its 125 miles of length steam-driven ships ply from its Bolivian to its Peruvian shores. Although its waters are very cold, it never becomes ice-bound. In it lies the Island of the Sun, a sacred place of the INCA people (q.v. Vol. I). The plateau provides most of the riches of Bolivia: it has the largest known

TIN MINES IN BOLIVIA. *Dorien Leigh*

deposits of tin in the world, besides oil and rich lodes of silver, gold, antimony, copper, lead, and many other minerals (*see* METAL ORES).

Eastward the plateau falls to the central plains or Chaco of South America, through large tracts of tropical forests and fertile agricultural land. Many medicinal plants are found in the forest, and rubber grows well. It was the difficulties in obtaining an outlet for the products of the eastern slopes of the Andes which led to the wars of 1928 and 1932 against Paraguay. Bolivia sought a right of way across the Chaco to the Paraguay river; but she failed to win—largely because the Bolivian troops, coming from the cool rarefied air of the Andes plateau down into the unaccustomed heat of the Chaco, succumbed to fever and the insect pests of the swamps. However, three railway routes have been built to the Pacific Ocean, though railway engineering is an expensive proposition in such a mountainous country, costing about £10,000 per mile.

About half of the 3,500,000 Bolivians are of pure Indian stock, for the region round Lake Titicaca was the cradle of the Inca Empire. Most of the Indians are now in touch with civilized life; but there is still a large proportion of illiteracy throughout the country.

There are two capitals, La Paz, the seat of government, and Sucre, the constitutional capital and centre of the Law Courts. La Paz, with a population of about 200,000, lies in a deep valley in the Andes plateau. It is very picturesque with its steep cobbled streets and Spanish-style houses. It has busy vegetable and livestock markets, much frequented by the Indians of the plateau, who sell there in large quantities their crops of maize and potatoes.

Sucre, with a population of about 30,000, stands on a plateau some 9,350 feet above sea-level in southern Bolivia. Cochabamba, the second-largest town in Bolivia, is the centre of a rich agricultural area, where wheat, maize, oranges, figs, grapes, and pears grow luxuriantly.

See also Vol. I: BOLIVIANS.

BOMBAY. Built on an island off the west coast of India in latitude 19° N., Bombay has one of the largest and safest natural harbours in the world, and one of the most beautiful. The fine sweep of the Bay, rising up to the wooded heights of Malabar Hill behind, and the modern sea-front buildings of the city itself, are a welcome sight to the traveller arriving by sea.

The island, which is 11 miles long by 3 broad, belonged to Portugal until 1661, when it was given to Britain as part of the dowry of Catharine of Braganza on her marriage to Charles II. By the beginning of the 18th century the East India Company had established a successful trading station and a fort where Bombay now stands. The fort has been demolished but the commercial quarter of the town, built on its site, is still called 'Fort'.

BOMBAY
High Commissioner for India

During the first half of the 19th century Bombay was eclipsed by Calcutta; but its natural advantages have again made it of the first importance. Causeways carry its railways to the mainland, from where they continue across the Indian plateau to Calcutta, and to the south of the peninsula. The most important factor in the rise of Bombay is the existence of the black Deccan soil on which cotton is grown in a large area to the north-east. Raw cotton is Bombay's principal export, and cotton-spinning and weaving her most important industry. Electric power generated in the Western Ghats is used for the factories.

Bombay is primarily a commercial city, engaged in the business of a great port, but in addition to business houses, the University and the Chief Presidency Court occupy fine buildings.

There are about 2,840,000 inhabitants, most of whom are Mahrattas; others are the Gujeratis, engaged in trade, and the PARSEES (q.v. Vol. I). There are about 100,000 Parsees altogether, most of whom live in Bombay. They own a large proportion of the cotton-mills—and, indeed, of the industrial power of India, including coal-mines and hydro-electric stations.

About 72 inches of rain fall during the summer monsoon season, but during the rest of the year cool sea-breezes temper the heat of the sun and make Bombay a pleasant place in which to live.

See also INDIA.

BORNEO, *see* EAST INDIES.

BOSPORUS, *see* BLACK SEA.

BOSTON. Despite its mixed population of nearly 750,000, in which there are 120,000 Jews, and many Irishmen and Lithuanians, Boston prides itself upon being the most English city in the U.S.A.

An Englishman, remembering the War of Independence and the part which the city played in resistance to England, may think this rather strange—unless he reflects that perhaps it was the English descent of the Bostonians of the

h century that made them so jealous of their rties.

'oston is built at the head of Massachusetts and is the chief city in New England. It had a chequered but most colourful history. t of all it was the stronghold of a very narrow, very energetic, form of Puritanism. Later ecame the leading city of rebellious colonists a sea-port of such fame that for many years, n to the time when the clipper ships were in glory, the term 'Boston men' meant all-ite American sailors. In more modern times ton's fame has been industrial and literary. ing the 19th century it was for a period the tural capital of America, gaining distinction m the presence of writers such as Prescott, tley, Parkman, Holmes, Whittier, and erson, and from association with others, h as Longfellow, Lowell, and Hawthorne, lived in Cambridge, the town of Harvard versity, across the River Charles. It became wn as 'the Athens of America'. To-day it is centre of a great industrial region, specializ-in the production of machinery of all kinds, iting, boots and shoes, soap, leather, and steds.

ston is a city of strong individuality. It has newspapers and periodicals of its own; it has provided the setting of two of the most ous of American novels—*Boston* by Upton lair, and *The Bostonians* by Henry James.

e also UNITED STATES OF AMERICA.

OULDER-CLAY, *see* ROCKS, Section 3 (*d*); GLACIATION.

BRAZIL. Everything in Brazil is on a grand scale—even mosquitoes grow to three-quarters of an inch in length. In area it is slightly larger than the United States of America without Alaska, but its population, about fifty-three millions, is only one-third as large. It lies almost entirely between the Equator and the Tropic of Capricorn (*see* Map, p. 415). It is the youngest of the South American republics, for until 1889 it was ruled by a king, and it is the only Portuguese-speaking republic in South America, having been originally colonized by Portugal.

The Amazon valley takes up northern Brazil. This vast lowland of the AMAZON (q.v.), the largest river in the world, with its thousand tributary streams and 30,000 miles of navigable waterways, stretches from Peru and Colombia in the west to the Atlantic Ocean in the east. Thick forests, swamps, and marshes, crossed by streams and cut by creeks, cover the whole valley. The rubber tree is one of the 50,000 different species of plant and tree. Seeds of the wild Brazilian rubber-tree were stolen and smuggled out of the country about 1875, and from these the plantations of Malaya and the East Indies were started. The forests abound in wild life. There are gigantic butterflies of brilliant colour, parrots, macaws, toucans, and other tropical birds; innumerable monkeys; pumas (large wild cats); alligators in the muddy shallows of the rivers; and snakes of all kinds, many poisonous. To combat the dangers of snake-bite the Government founded a snake-farm, where live snakes are kept so that the venom from them can be tapped and anti-snake-bite serum prepared. To keep up the supply of live snakes for the farm, a Brazilian law permits live snakes to be sent to it free of charge by rail.

TROPICAL FOREST IN NORTHERN BRAZIL
Royal Geographical Society

To the south the Brazilian Plateau rises steeply above the Amazon valley. Deep river

valleys cut it into regions, often called *campos.* These regions differ widely in climate and in appearance. Some are so dry as to be almost desert. In the north there is much tropical forest. The wide Matto Grosso area of the north-west is famous for its herds of cattle and for the maté tea shrubs of its forests. Round Sao Paulo there is a coffee-growing area of such immense yield that for years the Brazilian Government burned thousands of bags for which a market could not be found. However, chemists have now discovered that coffee can be used in the manufacture of PLASTICS (q.v. Vol. VII), and the surplus may be used up in this way. On the plains of Rio Grande do Sul in the south, great herds of cattle are reared, and wheat, maize, manioc, vines, rice, sugar, tobacco, and cotton are cultivated.

In the east the hilly Minas Geraes district is rich in minerals, particularly gold, diamonds, iron of high quality, and manganese. There is a single great mountain of iron-ore containing perhaps one-fourth of the total world supply. Lack of power is delaying the exploitation of this wealth, for the coal of Brazil is not suitable for industrial purposes, and the supply of electricity by water-power is not yet sufficient. The radio-active quartz crystals used in radar equipment come from Brazilian mines.

MARKET GARDENS NEAR SAO PAULO, BRAZIL
American Geographical Society

The plateau falls eastward by a cliffed edge, often over 2,000 feet high, to the sea or to a narrow coastal plain of swamps and marshes, alternating with sandy cultivated areas. The Portuguese settled originally along the coast of Brazil, and all the big towns except Manaos are on or near the coast. Manaos is an Amazon port about 1,600 miles upstream. RIO DE JANEIRO (q.v.), the capital, has perhaps the most spectacular city site in the world. Bahia, the first capital of Brazil, situated on a narrow coastal plain, has gradually spread on to an upper terrace, so that to-day the two parts of the city are connected by steep zigzag roads. Pernambuco (or Recife) is the third biggest town of Brazil and an important sugar port. Para (or Belem), at the Amazon mouth, is the chief rubber port.

Sao Paulo, though not a capital, is, however, with its 2,300,000 inhabitants, the third largest city of South America, and perhaps its most important industrial city. Its many cotton and jute mills, its big iron-smelting works, and a great variety of other factories are run by electricity generated by water-power near at hand. The absence of smoke makes Sao Paulo a very clean city, with fine buildings, gardens, and parks.

A large amount of the traffic of Brazil is carried by steamer, both along the coast and on the rivers of the Amazon network. Roads were formerly good only in and near the cities, but they are now being built throughout the country between the cities. Air transport is very important in a country where roads and railways are difficult to build, and frequent services link the main towns with each other, with the big cities of all the South American Republics, and also with Canada, the United States of America, and Europe.

See also SOUTH AMERICA.
See also Vol. I: BRAZILIANS.

BRISBANE, the capital of Queensland, Australia, is a city of about 400,000 inhabitants. It lies on the Brisbane River, about 12 miles from its mouth, and large ships are able to come right up and dock at its wharves. It was originally established, in 1824, as a penal settlement for convicts who had committed further crimes after transportation, and no free settlement was allowed within 50 miles. At that time it consisted wholly of huts for military and convict use. When convicts stopped being sent to

ustralia, the district was opened for free settle-
ent, and for a time the town flourished by
porting the wool from the large sheep-farms
n the Darling Downs. However, about 1844
he price of wool fell, and the city was hard hit
y an economic crisis. An energetic and far-
eing Presbyterian minister, Dr. John Dunmore
ang, tried to revive prosperity by new settle-
ent, and, in spite of official opposition, he
artered ships and sent 600 'virtuous Presby-
rians' specially selected in Scotland. The idea
as that they should grow cotton—but the
thorities refused to grant land. The experi-
ent failed—but the new settlers remained to
use fresh life into the town.

In 1859 Brisbane became the capital of the
w State of Queensland. It was still very small,
t as the resources of Queensland have been
veloped, it has grown steadily. Queensland
s great potential resources, and Brisbane will
ost certainly grow in size and importance.
people are perhaps more closely in touch with
pioneering atmosphere than other Austra-
city dwellers. Though the summers are
hot, the river brings a broad stretch of water
the heart of the city, and there is always a
breeze from it in the evening. A curious
ure of Brisbane is that nearly all its houses
large one-storeyed 'bungalows' built on high
ports to keep out insects that feed on wood.
is construction also allows air to circulate
eath the house—and it is not uncommon to
families eating the midday meal underneath
heir homes.

Brisbane has a famous boys' school, the Bris-
bane Grammar School. Its University, which
includes the old Government House, was
opened in 1909.

See also AUSTRALIA.

BRISTOL

Small ships dock right in the centre of the city. On the left is the Cathedral. *Port of Bristol Authority*

BRISTOL. This ancient city and port of Britain, with a population of about 450,000, is sometimes called the capital of south-west England. It was already a busy trading centre in the time of King Canute, when its principal import was wool from Ireland, and slaves its principal export. The Domesday Book classed it immediately after LONDON, YORK, and WINCHESTER (qq.v.) in importance. The discovery of America much increased Bristol's trade. Bristol-owned and Bristol-manned ships sailed to the New World. The original trade in white slaves was succeeded by a trade in black ones, brought from Africa and sent out to the West Indies to work in the sugar trade. To-day shipbuilding, engineering, tobacco, and cocoa products are among Bristol's main industries.

The town stands on the River Avon about 8 miles from the Bristol Channel, where the river marks the boundary between Gloucestershire and Somerset. It is surrounded by hills which at one point are so close on each side of the river that the valley is crossed by a suspension bridge. Bristol has a fine cathedral and some splendid churches, one of which, St. Mary Redcliffe, was called by Queen Elizabeth 'the fairest and most famous parish church in England'. Clifton, once a suburb of Bristol and now its western quarter, has mineral springs and a large public school. Bristol University was founded in 1909.

Bristol's history and interests have always been closely connected with the sea—so much so, in fact, that Pope described the city as having its 'streets full of ships'. The smaller ships still come up to the docks in the centre of the city, though the great docks for ocean-going ships are at Avonmouth and Portishead, where the Avon joins the mouth of the Severn on the Bristol Channel. Some famous voyages have started from Bristol—among them Cabot's first voyage to America in 1497, and then, in 1838, the first

steamship voyage to America, made by the *Great Western*.

See also ENGLAND.

BRITISH ISLES, *see* ENGLAND; SCOTLAND; IRELAND; WALES.

BRUGES, *see* BELGIUM.

BRUSSELS. The capital of Belgium began as a small settlement on one of the less swampy islands in the River Senne, a tributary of the River Schelde. In the 11th and 12th centuries Brussels grew rapidly, for it stood on the trading route from Bruges to Cologne. In the centuries following it was ravaged and pillaged in several wars and rebuilt patchily. Finally, after the separation of Belgium from Holland in 1830, the new Brussels was laid out, the aristocratic Quartier Leopold built, boulevards planned, and a bridge constructed over the Senne. It now has a population of well over a million.

Much of the medieval Brussels remains. The Cathedral of S. Gudule and S. Michael with its twin towers looks down over the city from a low hill. It was begun in 1170, but the greater part was built in the 15th century. The Grand' Place is the centre of the old town and one of the finest medieval squares in Europe. Guild-houses and the Broodhuis, an ancient office of weights and measures, line its sides, as does the beautiful Gothic Hôtel de Ville (Town Hall), its tall spire topped by a statue of S. Michael, the patron saint of the city. Here in the early morning a colourful fruit, vegetable, and flower market is held. Of the many other fine buildings in the city, perhaps the most notable are the 19th-century Palais de Justice which towers over the city, the Royal Palace, and the Bourse. The centre of the city is very gay, with neon lights shining on the restaurants, cinemas, and night-clubs

GRAND' PLACE, BRUSSELS
Belgian Marine, Railways, and Tourism

Brussels is a commercial and industrial city, too. Canals connect it to the Sambre and to the Schelde at Antwerp. Printing, publishing, brewing, distilling, sugar-refining, and engineering are all carried on. Fine lace and linen are important manufactures. Brussels carpets, however, are made, not in Brussels, but in Tournai.

Flemish is the language most commonly used, at any rate among the poorer people, though French is usually understood. In what used to be the weavers' part of the city, a language, partly Flemish, partly Walloon, is spoken.

See also BELGIUM.

BUCHAREST (pronounced 'Boocarest') is the capital of Roumania. The name is Albanian and means the 'Pleasant City'.

Bucharest stands on the River Dimbovitza, a tributary of the Danube, in the province of Wallachia near the southern border of Bulgaria. It is said to have been founded in the 15th century, on the site of a Roman fort. It was the capital of Wallachia until this state and Moldavia were united in 1862, when it became the capital of the Kingdom of Roumania.

Bucharest lies in flat country surrounded by marshes, many of which have been drained. With its many boulevards and wide avenues, and the River Dimbovitza running through it, the town looks fresh and open. The Roumanians call their capital the Paris of the East, both because it is supposed to have a likeness to the real Paris and because of the gay life which, despite wars and political troubles, its people live.

Roumania is an earthquake country, and earthquakes have destroyed much of Bucharest, so that it has few really old buildings. The large Cathedral of the Orthodox Eastern Church

lates from the 17th century. It stands on high round from which there is a fine view over the ity to the country beyond. The domes, towers, nd spires of churches, monasteries, and mosques ise picturesquely out of the parks and gardens. here is also a Roman Catholic Cathedral.

Bucharest, with a population exceeding 00,000, is by far the largest town in Roumania. is the seat of government, of education, and industry and trade, the headquarters of the my, and the centre of the railway system. In re royal palaces and the town houses of rich umanians.

See also ROUMANIA.

UDAPEST. The capital of Hungary, with a pulation of rather over a million, is really two es, Buda and Pest. They grew up on oppo- banks of the DANUBE (q.v.) at one of the few ces where it was easy to cross. Buda is on west bank on a long low hill, and the Hun- ians chose it in 1361 as their capital, partly ause it was easy to defend. Pest is on the ground of the east bank, and was the ting-place of many roads, where goods could ransferred to shipping on the Danube. Pest captured in 1526 and Buda in 1541 by the ks, and both cities were severely damaged. the Turks were driven out in 1686, the s were rebuilt and gradually became the t important capital in south-eastern Europe. 1944–5 the Germans held Budapest against ong Russian attacks, and again severe damage done.

Buda, with its much-restored Royal Palace, the Coronation Church, the great bronze statue of St. Stephen, and the irregular roofs of the small palaces of the nobles, makes a most charming and picturesque sight from the oppo- site side of the river. Floodlit on a summer night, it looks like an illustration in a fairy-tale.

Pest was built mainly in the second half of the 19th century with wide, well-planned, if rather uninteresting, streets. Its most attractive feature was a long tree-lined walk along the Danube, with hotels and cafés on one side, and on the other, quays and landing-stages for the busy steamers on the river. Unfortunately the buildings along this promenade were destroyed during the Russian-German fighting, though the great 'Gothic' parliament house and the government offices at one end suffered only superficial damage.

THE ROYAL PALACE, BUDAPEST, OVERLOOKING THE DANUBE
Royal Geographical Society

Six bridges, including the longest suspension bridge in Europe, linked Buda to Pest. Upstream of the city, Margaret Island lies in the Danube. It was a park with hotels, swimming-pools, restaurants, and cafés. In the summer months crowds went there to swim, dance, and listen to the gypsy orchestras so beloved by all Hungarians. The island was laid waste during the siege of 1944–5.

See also HUNGARY.

BUENOS AIRES is the capital of Argentina. The first Spanish colonists landed on the south bank of the Plate estuary. Mendoza who founded the first settlement christened it Puerto de Santa Maria de los Buenos Aires, in honour of Our Lady of Fair Winds, the patron saint of sailors. But these first settlers had a series of misfortunes, the remnants of them moving up the river into Paraguay—and it was not till 1580, forty years later, that the capital of Argentina was really founded. It is only within the last 100 years that Buenos Aires has grown to be the largest town of South America, and the third largest of the Western Hemisphere. In 1855 it had a population of only 90,000; by 1945 this had increased to 3,000,000, making it the largest city in South America. It had also grown tremendously wealthy.

Buenos Aires stands on practically level ground on the south bank of the estuary of the River Plate, where this is about 35 miles wide. Quays, docks, wharves, and warehouses stretch

[illegible] nearly 15 miles, handling cargo ships and passenger liners of many nations.

Buenos Aires, like most Spanish-American towns, has streets running parallel or at right-angles to each other, broken frequently by wide spacious squares. Of these the Plaza de Mayo is the most important. The Governor's Palace occupies its seaward end and the Cathedral stands at the north-west corner. From the Plaza de Mayo a wide main street, the Avenida de Mayo, runs west for 1½ miles to the other great square, the Plaza del Congreso. Here the huge domed Council Hall, the Palacio del Congreso, a fine specimen of modern Argentine architecture, occupies the whole of one side.

Close to the Avenida de Mayo lies an area of much narrower streets, relics of the early Spanish city. Most of the old buildings have gone, but here and there can still be seen an old one-storeyed house, built round a courtyard, and with no windows overlooking the street. The main shopping street of Buenos Aires, the Calle Florida, is in this area.

In the northern suburbs is a magnificent public park called the Palermo. Thinly wooded with palms and eucalyptus trees, this has facilities for boating, restaurants, an open-air theatre and a racecourse.

Buenos Aires is not an important city industrially. Its size and wealth are due to its being the one great commercial administrative centre of Argentina, and handling also a great deal of the country's export trade. Of recent years it has also become a very important railway terminus.

See also ARGENTINA.

BULGARIA. Every country in the Balkan Peninsula wants access to the Mediterranean. Bulgaria has been unsuccessful in her attempts to gain this, and her only two ports, Varna and Burgas, are on the Black Sea. The country stretches westward, from her short coastline to the middle of the Balkan Peninsula, in a rough rectangle about 300 miles from east to west and some 200 miles from north to south. The River Danube is the northern frontier except in the

A VILLAGE IN BULGARIA
Paul Popper

…eme east. Parallel to this, a long range of …ntains runs the full width of the country …n east to west, dividing it approximately into …ves. In the west this is connected by the lofty …teau on which stands Sofia, the capital, to … mighty ranges of the Rhodope Mountains. …e Bulgarian-Greek frontier runs along the …tern and Mediterranean slopes of the …dope. North and south of the central range … fertile plains (*see* Map, p. 160).

…he Rhodope Mountains cut off Bulgaria … the mild Mediterranean type of climate, … though summer is hot, winter is generally …ly cold with much snow and frost. There …tle mineral wealth in the country, and the …e are mainly farmers, shepherds, and …men, who work hard and live frugally. If … implements were available and more …ern methods of cultivation were to be …ved, it is estimated that the land could …rt more than four times its present popula… …f six millions. Cattle are raised in the … and sheep in the mountains. Sugar-beet …shes in the Danube plain, where, in the … maize is also grown, and wheat in the east. …e southern plain has a milder climate and …ces grapes, 'Turkish' tobacco, grain, and …orms. In the Kazanlik district roses are …n from which is distilled the famous 'attar …es'.

…FIA (q.v.) is the only large town. The ab…e of minerals and of any great industrializa… …coupled with the general difficulties of access … communication, has prevented the growth …rge cities, and Bulgaria is a land of villages … small towns set in sheltered lowlands and …lleys, amid bleak, unpopulated mountains.

BURMA. The only easy approach to Burma is from the sea. By the land, to the north-west, the Chin Hills and the Patkai Hills separate it from Bengal and Assam. In the north the Kachin Hills shut off Tibet and China. On the east the lofty Shan Plateau and the Tenasserim Hills give no easy routes to China, Indo-China, or Siam—though since the construction of the BURMA ROAD (q.v. Vol. IV) trade with China by land has become more possible (*see* Map, p. 229).

Burma is a land of mountains and great river valleys. Its main feature is the Irrawaddy lowland. This long valley, with its tributary valley the Chindwin, stretches from the Kachin Hills in the extreme north to the many mouths of the

NORTHERN BURMA, LOOKING NORTHWARDS TO THE MOUNTAINS OF THE TIBETAN FRONTIER

Royal Geographical Society

IRRAWADDY (q.v.) in the south. East of this are two other important river valleys, both running from north to south: the Sittang, separated from the Irrawaddy by a range of hills, and the Salween, lying still farther east and again separated by hills.

Rice is grown on the floors of the valleys and on great terraces formed in the lower slopes. In central Burma the valley of the Irrawaddy has a drier climate and the paddy (rice) fields have to be irrigated by canals, some of which are hundreds of years old. In this area, too, cotton, millet, ground-nuts, tobacco (for the famous Burma cheroots), and sugar are cultivated. In the Irrawaddy delta, rice is almost the only crop. After it has been harvested in November or December, the ground bakes hard in the heat, and the little fields with their low mud walls look grey and dusty; but when the rains come, they cover the ground with a sheet of shallow water, through which the bright emerald green of the young rice is soon visible.

Along the coast of Burma there are great stretches of unhealthy mangrove and swamp

A NATIVE BOAT ON A RIVER IN SOUTHERN BURMA
Royal Geographical Society

forest. Inland, the hills of the west and north are covered with thick forests—the tropical evergreens on the lower slopes, monsoon deciduous forests higher up, and coniferous forests higher still. The most important trees are the huge teaks of the monsoon forest. These are felled and carried, with the help of elephants, to the rivers down which they are floated to the ports. Besides wild elephants, there are tigers, bears, monkeys, rhinoceroses, and deer in the forests.

All Burma has a MONSOON (q.v.) climate; but conditions vary considerably from area to area. It is wettest on the coasts, and driest in central Burma (where the rainfall is only about 30 inches per year). During the cold season, from November to February, the climate is pleasant everywhere, but perhaps most pleasant on the Shan Plateau on the east, which is rather different from the rest of Burma. Here, the temperature seldom rises above 80° F. in the hot season, there are frosts in winter, and the summer rainfall is about 50 inches. In this district there is open pastureland, sometimes resembling the downlands of southern England. Pigs and poultry are reared, and there is much market-gardening and fruit-farming. Rice is grown in the valleys, and potatoes, oranges, and tea on the hill-sides. The limestone hills are riddled with caves and drained by underground streams. Gold, silver, jade, and amber are mined and quarried; but the most valuable mineral worked is petroleum.

In the far south, near Malaya, rubber is cultivated, and tin and tungsten are mined. On this far south coast lie the lovely islands of Mergui, with their sea-caves where the fishermen gather the birds'-nests which the Chinese use for soup.

Fishing is an important occupation. In the big rivers and all round the coast the Burmese fish with nets and traps, and cure much of the fish they catch. Pottery-making, wood- and ivory-carving, silk- and cotton-weaving are carried on, usually during the dry season.

The city of RANGOON (q.v.) is the capital of Burma. It has a mixed population, including Indian factory and ship-yard workers, and Chinese shopkeepers and market-gardeners. MANDALAY (q.v.) on the Irrawaddy in central Burma is an old capital of the Kings of Burma.

See also Vol. I: BURMESE.

BYELORUSSIA, or White Russia, is the republic of the U.S.S.R. which lies east of Poland and north of the Ukraine. It is a region of plains crossed by low ridges, running from north-east to south-west, and covered by thick forests with cultivated clearings. As the climate is damp and less extreme than farther east in the RUSSIAN SOVIET FEDERATIVE SOCIALIST REPUBLIC (q.v.) the forest or 'taiga' (*see* U.S.S.R.) is not entirely made up of coniferous trees, but also has oak-, lime-, and ash-trees. In the south there is an area of bog and marsh, which is broken only by small clumps of trees on the higher ground—a very dreary landscape of reeds, coarse grasses, and moorland. These marshes, the Pripet Marshes, extend west into Poland and south into northern Ukraine (*see* MARSH AND MOORLAND).

Dairy-farming and pig-breeding are important, but the most important industry is forestry. Peat is used to generate electricity.

Minsk, the capital and the largest city, was founded about the 11th century as a trading city. The modern part is spacious and well planned. It is important as a railway junction and for its manufactures. Vitebsk, the second largest city, is on the West Dvina River. It has important light industries and also manufactures agricultural machinery. It is possible to travel by water from the Baltic, by the West Dvina and the Dnieper, to the Black Sea.

See also Vol. I: RUSSIANS.

C

CAIRNGORM, *see* ROCK-CRYSTAL.

CAIRO. This city is the capital of modern EGYPT (q.v.), and the largest town in Africa. It is a busy, noisy, and cosmopolitan city with a population of about 2,100,000 made up of a great mixture of nationalities, including many Europeans. The city stands on the River NILE (q.v.), near the head of the delta. Its position has always been important, as it is on the main overland route between Asia and Africa, and Cairo has been a great trading centre for a long time. The opening of the SUEZ CANAL (q.v. Vol. IV) increased its strategic importance.

The history of Cairo goes back to 525 B.C., when the Persians conquered Egypt and made a settlement there. Later, the Romans used the little town as a military headquarters. When the ARABS (q.v. Vol. I) spread over North Africa in the 7th century, they developed Cairo as the centre and capital of their empire; and, ever since, the greatest influence in its growth has been Arab. With its narrow, winding streets, and minareted highly decorated mosques, the old city is typically Arab in architecture. The Citadel, the old fortress, standing on a spur of the hills above the city, was built in 1166 by Saladin. The famous University, el-Azhar, with its 12,000 students, is the chief university of ISLAM (q.v. Vol. I). Cairo is now the centre of the Arab League, the political power of Islam.

CAIRO: THE CITADEL, AN OLD FORTRESS, OVERLOOKS THE CITY

The most interesting part of Cairo is the old city, where centuries-old handcrafts, such as hand-beaten silver work, leather work, and carpet-making, are carried on in workshops consisting of small wooden houses with verandas opening on to narrow streets. The craftsmen in their Arab dress, often surrounded by admiring friends and prospective customers, sit on the verandas, using tools and designs of very great age. The Egyptian Museum has a magnificent collection of the valuable treasures and relics unearthed from the tombs of ancient Egypt (*see* EGYPTIAN CIVILIZATION, Vol. I), including the particularly famous collection from the tomb of Tutankhamen.

See also EGYPT.

CALCUTTA, the chief port of India, lies on the Hooghly River, in the delta of the GANGES (q.v.), 80 miles from the Bay of Bengal. Through it pass most of the exports and imports of the densely populated great northern plain of India. The width of the river here varies from a quarter of a mile to almost a mile, and Calcutta is connected by bridge with Howrah on the opposite bank, from where railway lines radiate to other parts of India.

Calcutta was founded in 1690 by the EAST INDIA COMPANY (q.v. Vol. VII), as a trading factory. The site was unhealthy and subject to floods, and the early inhabitants had great difficulties to overcome. However, trade was profitable enough to encourage their perseverance. In 1756 the ruler of Bengal unexpectedly attacked the town and, after a two days' siege, sacked it, imprisoning some of the inhabitants in the famous 'Black Hole'. It was recaptured seven months later. In 1757, after the Battle of Plassey, Bengal was pacified, and the position of the East India Company greatly strengthened. An era of prosperity followed, during which trade flourished, and Calcutta grew in size and wealth. Large areas

[illegible] High Commissioner for India

[illegible]

[illegible] Calcutta came to be known as the 'City of Palaces'. [illegible]

[illegible] to the European quarter of the city [illegible]

[illegible] and crowds across the [illegible] population is predominantly [illegible]

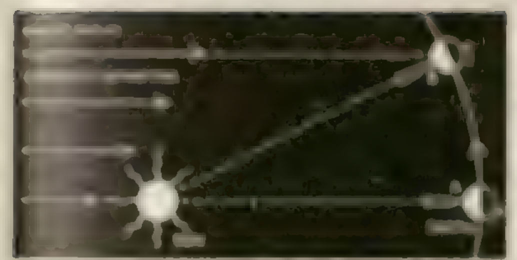
[illegible] floating on the muddy waters [illegible] the river.

Calcutta is the commercial and [illegible] capital of India. It was the [illegible] capital also until 1912, when the [illegible] of India moved to New Delhi. [illegible] industry is the manufacture of jute [illegible] and cotton. Shipbuilding and engineering [illegible] also carried on, and factories and [illegible] the river banks for 10 miles. The [illegible] tion of Greater Howrah is about [illegible] which makes the city the second largest [illegible] British Commonwealth.

Temperature averages 80° F., rising to [illegible]° F. in the hot season, and rarely falling below [illegible]° F. in the cold season, so that fire-places are [illegible] built even in European houses. Sixty inches of rain falls between June and September [illegible] air is humid, especially during the [illegible]

CALENDAR. It is much easier to measure Time than it is to understand it (see Time [illegible] even to measure it, we have first of all [illegible] [illegible] movement to measure by. The daily and annual movements of the heavenly bodies suggested themselves, of course, from the very [illegible] Division of time into days and years by the [illegible] [illegible] watched for the day on which the star Sirius [illegible] just showed above the horizon before sunrise, and they counted their year from that day, and it can scarcely be by accident [illegible] certain features in the design of the Pyramids and of Stonehenge (q.v. Vol. I) enable the [illegible] almost exactly on the Sacrificial Stone. [illegible]

[illegible]



or back in bigger stages than 4 minutes as we come to each new zone with a local time of its own.

If one ship travels eastwards as far as 180°, to the exact opposite side of the globe, and another ship travels westwards to the same spot, one ship will have gained and the other have lost 12 hours. So the difference in time between them will be a whole day. Each has to adjust—the eastward ship by calling two consecutive days by the same name, the westward ship by missing out the name of one day altogether. The line of longitude where the day of the week suddenly changes, is called the International Date Line. For convenience' sake, it does not follow longitude 180° exactly, but curves to avoid inhabited land, since a change of day between one village and another would obviously be awkward.

The Greenwich Transit Telescope was chosen by international agreement in 1884 to fix longitude 0° for the world, though it and earlier telescopes had been used for this purpose in Great Britain ever since 1738.

To check the time, the telescope is rotated vertically towards a suitable star, and a practised observer makes electrical contacts just as the star's image crosses the fine vertical cross-wires in the eyepiece. A pen which automatically makes a straight line on a steadily revolving drum of paper—a chronograph—is moved both by these contacts and also by regular pulses sent out from the observatory clock, so that a very exact comparison between star time and clock time is possible. The comparison can be made at leisure after the observations are complete. Greenwich Observatory possesses the most accurate clocks that can be made—capable of keeping time to within a hundredth of a second a day (*see* CLOCKS, Vol. VIII).

From delicate astronomical measurements extending over a long period, it seems that the Earth is gradually slowing down—perhaps on account of the constant braking action of the TIDES (q.v.). Eventually this effect may be shown up by our clocks. Apart from this, however, there are unexplained irregularities in the Earth's rotation amounting to about one-thousandth of a second per day.

Hours, minutes, and seconds are easily obtained by subdivision of the Mean Solar Day, our fundamental unit of time; but the Year is also a very important natural unit, and it, too, has to be accurately fitted in with the day. This is not at all easy. As early as 125 B.C. the length of the year was measured in two separate ways: (*a*) as the interval between two successive summer 'solstices'—the day on which noonday shadows were shortest; and (*b*) as the interval between those particular days when the Sun rose simultaneously with a certain star. The former is the shorter by about 20 minutes, owing to the 'precession', the slow circular swing of the Earth's axis described in the article on EARTH—and it was this interval which was chosen as the Year. Its length is approximately that of 365¼ mean solar days.

Our lives are affected so much both by the daily succession of light and darkness, and by the annual succession of the seasons, that it is quite necessary to keep both units, even though the year is made up of such a very awkward number of days. It is obviously convenient to have a whole number (without a fraction) of days in a calendar year—but a year of 365 days is too short, one of 366 too long. We owe the idea of Leap Year to an Alexandrian astronomer whom Julius Caesar called upon to deal with the confused state of the calendar in 46 B.C., the 'year of confusion' which contained 445 days.

The arrangement then made was that the year (which had formerly commenced in March) should start on 1 January, on the day of the new moon following the winter solstice (or shortest day) in the year we now call 45 B.C. And every four years a leap year of 366 days was to be observed. The error in this was very small; but by A.D. 1582 it had added up to so much that Pope Gregory XIII had to call upon an astronomer for advice, because the Easter celebrations were getting too far away from the spring equinox (the day in March when night and day are of equal length).

The new leap year rule was that the first year of any century should *not* be a leap year unless its date could be divided by 400—that is to say, 1700, 1800, and 1900 were not leap years, but A.D. 2000 will be. This is the rule we now keep, and its error is only about one day in 4,000 years. To put the accumulated errors right, 4 October 1582 was followed immediately by 15 October, instead of by 5 October, ten days thus being missed out. England adopted this Gregorian calendar in 1752, when we had to let 2 September be followed by 14 September. The

ıst 2 months 24 days of the year 1751 had also ı be missed, because with the adoption of this ılendar, 1 January became New Year's Day, stead of 25 March as hitherto. Our present stem of numbering the years B.C. or A.D., from birth of Christ, was adopted in A.D. 540. ıtil then, the Christian world had followed Roman system of counting the years from foundation of Rome—'Anno Urbis Con- ıe'. Thus A.U.C. 1294 became A.D. 540. It has ce been shown that there is an uncertainty ıut this A.D. 540, which should perhaps have n A.D. 544, as it is probable that the actual r of Christ's birth was nearer our date B.C. than A.D. 1.

ıee also Astronomy, Modern; Astronomy, History of.

ALIFORNIA, *see* United States of America.

MEROONS, *see* Guinea Lands.

NADA. The Dominion of Canada occupies thern North America except for Alaska .). Newfoundland (q.v.) and the coastal ı of Labrador have now also joined Canada. bounded by three oceans: the Arctic on north, the Pacific on the west, and the ıntic on the east. The Great Lakes and United States of America (qq.v.) lie to south. Much of the exploration of Canada s done from her many rivers; but their commercial usefulness is lessened by their freezing during the hard winter and by their turbulence. The Mackenzie is the longest and the St. Lawrence (qq.v.) the most important. The rapids of the St. Lawrence have been avoided by the constructiou of canals, notably the Welland Ship Canal (q.v. Vol. IV). Railways, of which the chief are the Canadian Pacific and the Canadian National, have opened up vast tracts of country, and made the exploitation of Canada's resources possible. In more recent times motor transport and air traffic have come to play greatly increased parts.

Canada can be divided conveniently into five main regions: the Maritime Provinces of the east, the central area of Quebec and Ontario, the Prairies, British Columbia, and the Canadian North.

The three Maritime Provinces—Nova Scotia, New Brunswick, and Prince Edward Island—are inhabited mainly by people of English and Scottish descent (Nova Scotia means New Scotland). They are hilly, and their warm summers and bracing climate have made them favourite places for holidays. Fishing, farming, and lumbering are all important, and the apple-orchards of Nova Scotia are among the finest in Canada. Halifax is an important port, and is never icebound. Cape Breton Island has very large ironworks and the biggest coal-mines in Canada. On Prince Edward Island there is one of the biggest fur-farms in the world, where foxes are bred for their skins. During the great days of sail there were many shipbuilding yards on the Bay of Fundy, and ships from these coasts were to be seen on all the seas of the world. Their many coves and inlets once made them a favourite resort of pirates and smugglers. To-day they are less prosperous—it has even been said that the main export of Nova Scotia is its young men, who go to some other part of Canada or to the United States of America to seek their fortunes.

The provinces of Ontario and Quebec stretch

CANADA

THE COAST OF CAPE BRETON ISLAND, NOVA SCOTIA
Canadian National Film Board

from Hudson Bay to the U.S.A. Ontario contains one-third of the population of Canada, and more than half the wealth; Quebec has more than one-quarter of the population, and its industries and manufactures are second only to those of Ontario. Both provinces have very extensive, rich farmlands, and many forests yielding valuable timber and wood-pulp. The most thickly populated areas are the lowlands of the St. Lawrence, where big cities like Toronto and MONTREAL (q.v.) have sprung up. Water-power has been used to the utmost in developing industry. About one-tenth of the world's gold is mined in Canada, mostly in Ontario, and Quebec has the largest asbestos mines in the world. Gold, asbestos, nickel, copper, zinc, and lead are exported. The northern part of both provinces is a land of rocks, woods, great lakes, and rivers. But even in the farthest north, where Indians still travel in canoes, and where the fur-trapper works in a wilderness as wild as when the first explorers saw it, men have found minerals, built townships, constructed railways, and made fortunes.

The three prairie provinces of Manitoba, Saskatchewan, and Alberta extend westwards from the Great Lakes to the Rockies, and north to Hudson Bay. In Alberta, oil has been discovered at Leduc, and there is coal-mining at Edmonton. There is some cattle-raising, but the main wealth of the provinces depends upon the supply of wheat. Life in the prairies is built round the wheat crop: if it is good the farmer and his family can spend the winter in British Columbia or California; but if it is bad they must stay at home and make the best of their bleak surroundings. Since the First World War, droughts, hailstorms, plagues of grasshoppers, and the unsettled condition of the world have produced more bad than good years. There is little variety in the prairies, except that produced by the seasons. In winter they are white and cold and men in sheepskin coats drive sledges or shiver at station platforms; in spring they are black with the dark water of melting snow; in summer they are green with the first wheat sprouts; in autumn, tall, yellow ears ripple in the wind as far as the eye can see.

Many cities have grown up on the prairies. The chief is the great grain-distributing centre of Winnipeg; next in size is Edmonton, the capital of Alberta; and then Calgary, near which there are big ranches as well as wheat farms. Western Alberta is part of the ROCKY MOUNTAINS (q.v.); and here there are two National Parks, the Banff and the Jasper, where wild animals like moose, deer, and bears live fearlessly and without interference in natural surroundings, against a wonderful background of mountain, forest, and lake scenery.

The loveliest part of Canada is British Columbia, which stretches from the Rockies to the Pacific coast. One of its first discoverers, Captain Vancouver, whose name is immortalized in its chief city, could find no words adequate to describe its beauty. It is rich in everything—timber, minerals, fruit, furs, game, and fish in its seas and rivers. The capital, Victoria, is a very busy port which has a big trade with the Pacific coast of the United States and with the Far East. Like other Pacific coast towns, its importance has been increased by the opening of the PANAMA CANAL (q.v. Vol. IV). The chief river is the Fraser, famed for its salmon. Everything is on a gigantic scale in British Columbia—the mountains, the valleys, the lakes, and the rivers. Much of it is still

THE PRAIRIES: A FARM AT SWIFT CURRENT, SASKATCHEWAN
Canadian National Film Board

unexplored, and there are many wild animals such as bears, wolves, deer, moose, and caribou. Climate varies, but in the coastal regions it is mild and pleasant.

The most northern parts of Canada are the Yukon, famous for the gold-rush to the Klondike in 1896, and the North-West Territories, covering in all about one-third of the total area of the Dominion. Until recently, this was a wilderness of great rivers and virgin forests; but the building of the ALASKA HIGHWAY (q.v. Vol. IV) and the inauguration of air-routes are bringing great changes. Already oil-fields and mineral resources have been developed, and engineers and prospectors are outnumbering trappers, explorers, and missionaries. Travel is still usually by canoe in summer and sleigh in winter however—and in the far north, polar bears will for long continue to make their homes in the icy Arctic wastes.

See also OTTAWA; QUEBEC; MONTREAL.
See also Vol. I: CANADIANS.
See also Vol. VI: FUR-HUNTING AND TRAPPING; FUR-FARMING; SALMON-FISHING.

CANARY ISLANDS. The first sight of the Canary Islands one gets is the great conical peak of Teneriffe, ringed with clouds. Standing 12,196 feet high, this is visible 140 miles away. Teneriffe Island is the largest of the group, and it possesses as its capital city Santa Cruz. The harbour is excellent, and ships call there to collect the produce of the islands, and to disembark tourists. The seven islands of the Canary Group belong to Spain—the other six being called Gran Canaria (capital Las Palmas), Palma, Ferro, Gomera, Fuerteventura, Lanzarote. The islands, which are volcanic in origin, rise from the Atlantic 60 miles off the coast of Africa, and over 700 miles south of Gibraltar (*see* Map, p. 322). The climate is ideal, with a range in temperature from 50° F. to 95° F., and moderate rainfall. Tropical produce is grown, bananas being the chief export, though oranges, tomatoes, vegetables, and tobacco are also exported, and wine is produced. Cochineal, made from the bodies of insects found in the prickly pear plant, is another important product in the Canaries.

TENERIFFE
Dorien Leigh

With their white-walled towns standing out against a background of trees, the islands are popular with holiday-makers. Their climate makes them particularly suitable for invalids and convalescents. The total population of the Canary Islands is just over 500,000.

CANBERRA is the capital city and centre of government of the whole Commonwealth of Australia. It is situated in the Australian Capital Territory, a small area of land on a tableland about 2,000 feet high in New South Wales. Canberra dates only from 1908, and most of it has been built since the First World War. It is unusual in being specially planned and built as a capital.

The plan submitted, in a world-wide competition, by a young American architect, W. Burley Griffin, was chosen by the Australian Government, and work went ahead so fast that by 1927 Parliament was able to meet in its new quarters. Parliament House was opened by King George VI, then Duke of York. A very great majority of the population—about 16,000—are public servants and their families. There are also the legations of all the foreign countries with which Australia has diplomatic relations. Canberra attracts a stream of visitors from other parts of Australia and from all over the world.

The city is most beautifully situated on the River Molonglo, surrounded by a ring of low hills and with the Australian Alps, often snow-covered, in the background. The city is well-planned with open spaces, gardens, and great variety of trees. No land in Canberra is privately owned, for the whole territory belongs to the nation. The people are keen gardeners, and as no fences are allowed, the gardens in front of every house can be seen over the low hedges which divide them from the road. In spring the city is a blaze of yellow wattle (mimosa), followed by flowering plum, almond, and peach blossom, and in autumn, as the poplars, elms, and Canadian pin-oaks change their colours, it is a city of gold and crimson.

Canberra, as well as being the centre of the Australian Government, is becoming also a centre of culture and research. The National Library contains one of the world's best collections of books and maps dealing with Australia and the Pacific. Research institutes, schools, and laboratories are growing up, and plans are now being made for the establishment of a National University.

CANTON. This is the chief city of south China, with a population of one million. Canton has been for centuries one of the great trading ports of the Far East: it was a port of call for Arab *dhows* in the late Middle Ages; and in the 17th century it was the first port of China to be visited by European traders—Portuguese, Dutch, and British. But the Chinese did not welcome contact with Europe, and over a century passed before a war with Britain ended their resistance to western trade.

To-day Canton is in a transitional stage between the old and the up to date. It presents a curious mixture, areas of narrow, evil-smelling lanes alternating with wide streets set with modern buildings. From its situation on the northern edge of the Si-kiang delta it looks with covetous eyes upon the island of HONG KONG (q.v.), 90 miles away, the great shipping centre of all this part of the world. To rival Hong Kong, however, Canton would have to dredge her

river, so as to give access to large ocean vessels.

A large part of the wealth of Canton comes from money sent home by prosperous Chinese communities living abroad, for Canton and the district round it are the main areas of Chinese emigration.

See also China; Si-kiang River.

CANYONS, *see* Valleys.

CAPE TOWN. The oldest city in South Africa, and legislative capital of the Union of South Africa, has a population of 470,000, of which a[illegible] 220,000 are white.

Cape Town grew up at the head of Table Bay at the southern tip of Africa. It is sheltered from the southern gales by the semicircle of mountains which surround it.

Table Mountain (3,582 feet), rising steeply from the bay, appears from below to be quite flat on top—hence, of course, its name. Actually, the top is undulating, and has several shallow valleys. On one side it is flanked by Devil's Peak, and on the other by a hill called Lion's Head. Cape Town, as it grew up, spread behind Devil's Peak to the suburbs, such as Rondebosch and Newlands. The first Dutch settlers under their Commander Jan van Riebeeck settled in 1[illegible] on the slopes of Table Mountain, and several of their beautiful gabled houses still remain.

Table Bay used to be called 'the Tavern of the Seas', as it was a sort of half-way house between Europe and India. To-day it is a modern harbour which, in spite of the Suez Canal, still handles a great deal of shipping. During the Second World War, when the Mediterranean route could not be used, it was of very great importance.

Cape Town's main street is Adderley Street, called after a British M.P. who helped to prevent the Cape from becoming a penal settlement about 100 years ago. In this street, coloured flower-sellers offer for sale the brilliant, beautiful flowers for which the area is famous.

The Parliament of the Union of South Africa meets at Cape Town from January to June. As the administrative offices of the Government are 1,000 miles away at Pretoria, there is a big migration of officials twice a year: in January to Cape Town and back to Pretoria in June.

Table Mountain provides wonderful rock-climbing, and the Cape Town Mountaineering Club has worked out many easy and difficult routes up. The famous South African, General Smuts (q.v. Vol. V), a keen mountaineer, described Table Mountain as South Africa's Cathedral. At Rondebosch on the slopes of the mountain is Groots Schuur (The Great Barn), where Cecil Rhodes (q.v. Vol. V) lived in a house built in the Old Cape Dutch style. He left the house to the nation in his will, and it is now occupied by the Prime Minister of the Union—a South African 'Chequers'. At Newlands are the most famous rugby and cricket grounds in South Africa.

At certain times of the summer, when the south-east trade wind blows, the top of Table Mountain is covered with masses of cloud—the famous 'tablecloth'. An old legend says that these clouds are smoke coming from the Devil's pipe—the Devil himself sitting on the nearby Devil's Peak.

See also South Africa.

CARBONIFEROUS AGE, *see* Earth, History of (Chart).

CARDIFF, *see* Wales.

CAPE TOWN AND TABLE MOUNTAIN
South African Railways

CARIBBEAN SEA, *see* West Indies.

CARPATHIANS. These are a range of mountains extending through Czechoslovakia, south Poland, and Roumania (qq.v.). They stretch for 600 miles in an arc from Vienna to the Iron Gate, where the Danube (q.v.) leaves the plain of Hungary in a narrow gorge (*see* Map, p. 160).

The highest mountains of the Carpathian range are in the west, in Czechoslovakia, where the granite peaks of the high Tatra rise to nearly 9,000 feet. They have been carved into rugged, fantastic shapes by ice action, and tower, snow-covered, above the lower forested slopes. They are visited by a great many tourists.

To the north lie the West Beskid Mountains. They are composed of sandstones, with rounded summits, covered with forest, and rarely exceed 4,000 feet in height. The Vistula and Oder rise in the West Beskids, and flow northward to the plain of Poland.

South of the Tatra are sheltered valleys, intensely cultivated. Small deposits of iron, gold, silver, and copper are found nearby. In the Middle Ages colonists from Germany came to work these minerals, and they succeeded in building up a flourishing mining industry. To-day the industry has decayed, but the descendants of the German colonists, called 'Zips', for a long time preserved the German language, customs, and dress. The Zips' towns are picturesque and rich in medieval buildings.

THE TATRA MOUNTAINS OF CZECHOSLOVAKIA, THE HIGHEST PART OF THE CARPATHIANS
The Czechoslovak Embassy

Eastwards the Carpathians become narrow and low, and several easy passes connect the Hungarian and Polish plains. This part of the Carpathian range is called the East Beskids. It is covered with forest, which is broken by broad fertile valleys. The people are backward, and cling to old-fashioned methods of agriculture, and to their traditional customs and dress.

The most eastern part of the Carpathians forms a triangle of mountains in Roumania, surrounding the basin of Transylvania. The eastern side of the triangle consists of a well-forested sandstone range. In some places clearings in the forest have been made to allow sheep to graze. Nestling among the mountains are sheltered and well-cultivated patches of farmland. The southern side of the mountain triangle is the Transylvanian Alps, ending in the west at the Iron Gate. Here the mountains are high enough to stand above the forest level, and the scenery is magnificent. Sheep are pastured on the mountain slopes in summer, and driven down to the plains in winter, when the high pastures are covered with snow.

The Bihorulu Mountains, ranges of ancient crystalline rocks, separate Transylvania from the Danube Plain to the west. Volcanic activity at a more recent date has provided in places veins of gold and silver which used to be worked, but now the industry is at a standstill. The chief occupation of the scanty population is sheep-rearing. Transylvania itself lies 1,500 to 2,000 feet above sea-level, the sandstones and clays of which it is formed providing fertile soils on which maize and wheat are the principal crops. Mixed farming is the rule, and pasture land, orchards, and vineyards alternate with the arable fields. The largest town is Cluj, with a population of 97,000. Transylvania is shut off from modern influences by its surrounding mountains. The old-fashioned costumes of the people and the picturesque towns give it an air of enchantment.

See also Mountain Building.

CASPIAN SEA. Although completely surrounded by land, the Caspian Sea is as large as

FISHING BOATS ON THE CASPIAN SEA
E.N.A.

Britain and was once much larger. Indeed, as recently as 15,000 years ago its northern end curved round to the Black Sea in the west and the Aral Sea in the east; but as the climate grew warmer and drier, it slowly withdrew into its present basin, where its surface is now about 85 feet below that of the oceans. As its waters evaporated, it grew more salty (like the much smaller Dead Sea), and its shallow northern half might by now have become a salt-marsh or desert but for the fact that Europe's mightiest river, the VOLGA (q.v.), steadily pours into it a flood of muddy water, almost vast enough to counterbalance its losses by evaporation (*see* Map, p. 17).

At its northern end, where it receives the Volga, the Caspian Sea is fairly shallow, so that its comparatively fresh water usually freezes over in the cold continental winters; the southern part of the Caspian, however, is very salt and very deep. To the west it is bordered by the snow-topped Caucasus, to the south by the forested Elburz Mountains of northern Persia, while to the east stretch the plains of the southern U.S.S.R. The flat northern and eastern shores of the Sea are sparsely peopled, for the climate is too dry to support much cultivation. There are more people in the south-western shores, in Azerbaijan and in Persia, where the melting snows of the mountains irrigate the land.

The Caspian has long been famous for its sturgeon. These royal fish, often more than 15 feet long, are very good to eat, and the oily roe of the females, known as caviare, is exported as a great delicacy—though it is everyday fare to the local fishermen. Far more important economically than this, however, are the oil-wells on the western coast, around the city of Baku. Tank steamers, built locally or brought in sections from the Baltic down the Volga, carry the oil to Astrakhan at the head of the Volga delta, and from thence great barges take it upstream to the industrial heart of Russia. There is also an oil-pipe-line from Baku to the Black Sea at Batum.

Baku, capital of the Soviet Republic of AZERBAIJAN (q.v.), is now a great industrial city and port, peopled mainly by Armenians and Russians. The centre of the old town, with its mosques and narrow alleys, still remains as a reminder of its Persian past. Astrakhan recalls by its name the sheep and lambs of the flat steppes that surround it, where even to-day Russian COSSACKS (q.v. Vol. I) and Turkoman tribesmen in sheepskin coats and *kaftans* tend their flocks and herds.

See also Vol. I: SOVIET CENTRAL ASIAN PEOPLES.

CAUCASUS. The Caucasus Mountains run 750 miles north-west–south-east from the Black Sea to the Caspian Sea. In the north they rise relatively gently from foothills and plateaux; southwards they are connected to the mountains of Transcaucasia and the Armenian Highlands by the Suram Mountains. To the east and west

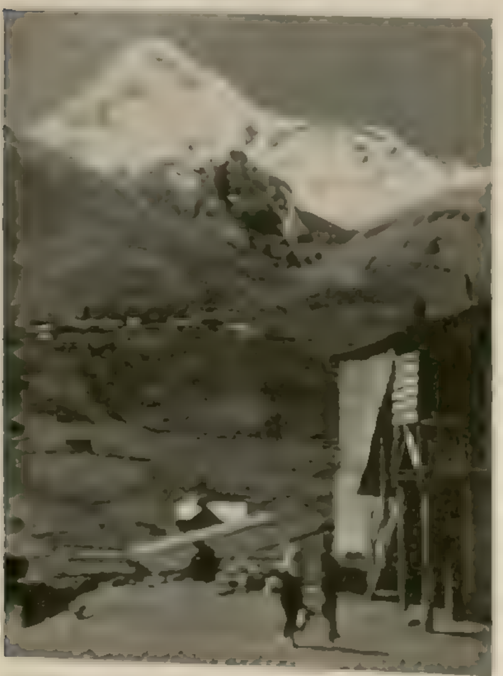
THE CAUCASUS

of the Suram Mountains they fall sharply south to the Kura valley and to the Rion valley.

The Caucasus are a series of high parallel ranges linked by mountain blocks which cut off

valleys and depressions from one another. At their widest part they extend about 100 miles from north to south. In the west they are mainly [illegible]. Farther east the rocks are volcanic and crystalline, and the highest peaks are over 15,000 feet above sea-level. Mount Elbrus, the highest, rise to 18,470 feet. Permanent snow lies at about 10,000 feet and there are great glaciers and snowfields providing water-power for the generation of electricity. The lower mountain slopes are thickly forested with oak, ash, pear, apple, maple, lime, and horn-beam. Higher up there are beech forests, while the high mountain-sides have pines and firs. These forests are being exploited and timber-using industries are developing.

The eastern part of the Caucasus is lower, and with a drier climate, the mountain slopes are generally treeless. In the extreme east, in Dagestan, part of the R.S.F.S.R., there are great [illegible] cut by steep-sided depressions and narrow gorge-like valleys. Until recently Dagestan was an area of small groups of peoples, isolated from each other and from the outer world, with manners, customs, and [illegible] of their own. But the building of



KAZBEK, ONE OF THE HIGHEST PEAKS IN THE CAUCASUS
Planet News

roads, and the encouragement of cattle-reari[ng] and of vine-growing in the valleys are bring[ing] rapid economic development.

From early times the Caucasus have been t[he] scene of much fighting. They lie across t[he] historic trade-route from Asia to Eur[ope]. Roman soldiers fought for them, as did Mong[ols], Persians, Arabs, and Turks. In the 19th c[en]tury they were conquered by Russia, and to-d[ay] they lie wholly within the U.S.S.R.

CAVES. In regions where limestone rocks co[me] near the earth's surface, caves are often fou[nd]. Rain-water—which is a weak acid, since it [has] carbon dioxide from the air dissolved in i[t]—attacks the limestone (*see* EROSION). Cra[cks] appear along weak places in the rock betw[een] its layers, and these soon become wide sp[lits]. The splits which connect with the surface [are] called 'sinks' or 'swallow holes', and of[ten] streams disappear underground down the[m]. The water makes extensive galleries in the h[eart] of the rock, joined to each other by verti[cal] shafts or 'pipes'. In the course of time t[he] galleries are enlarged, partly by the chemi[cal] action of the water on the rock, and partly [by] the mechanical action of underground strea[ms] and the debris which the streams carry with the[m].

As the process of underground erosion [(or] wearing away) is continued, large chambers a[re] formed, especially when two or more galleries a[re] joined together by the collapse of the interveni[ng] rocks. Some of these caves have undergroun[d] rivers flowing through them; but sometim[es] the course of the river has changed, and th[e] cave floor is dry and sandy. Limestone cave[s] are connected to each other by systems of galleries—often covering many miles underground, as in the gigantic Mammoth Caves in Kentucky, U.S.A. These caves are generally well ventilated, since air passes along the galleries, which are connected to the surface by the 'swallow holes'.

STALAGMITES AND STALACTITES. As water charged with carbon dioxide percolates down through limestone rocks to the roof of the cave, it dissolves some of the limestone, and hangs from the roof in a drop. A small quantity of the water is evaporated from the drop, so that calcium carbonate is deposited on the roof of the cave. As drop follows drop, a tube or 'icicle' of calcium carbonate is formed, and this is called a stalactite. But sometimes the drop, instead of

STALACTITES AND STALAGMITES IN THE CANGO CAVES, SOUTH AFRICA

...ing to the roof, falls to the floor, and so a ... is slowly built up under the stalactite. ... is called a stalagmite. Eventually, stalactite ... stalagmite grow towards each other and ..., and a glistening crystalline pillar extends ... floor to ceiling of the cave. Sometimes ... dissolved in the water give tinges of colour ...e deposits, so that the interior of the cave ...ies white and blue. Stalactites and stalag...tes are often joined together in curtain-like ...nations, fringed along the edges with small ...icles'.

Caves are also found in cliffs along the sea-shore. These are formed by the battering of waves against weak places in the rock, until finally, cracks open up between the beds. As waves dash against the cliff, the air in the cracks (or fissures) is compressed, and as the waves recede the compressed air is released with explosive force. Soon tunnels are formed, which extend into caves. Sometimes a tunnel communicates with the earth's surface far inland, and this outlet is called a 'blow hole', since, during a storm, spray is forced through it like a fountain by the force of the waves travelling through the cave.

In days gone by SMUGGLERS (q.v. Vol. X) used these caves, some of which were large enough for boats to enter direct from the sea.

Sometimes, after continued battering by the sea, the cave roof gives way, and the walls are left standing up in the sea as isolated pillars, or 'stacks', like the 'Old Man of Hoy' off the coast of Scotland.

In the early days of man's life on the earth, caves offered him a secure home, where he was safe from wild animals. Many generations of primitive men lived in caves, and their relics are found buried in the floor (*see* CAVE MAN, Vol. I). Therefore, caves are of great interest to the anthropologist, who can piece together the story of their former inhabitants from deposits found on the floors.

Among the world's largest caves are the Mammoth Caves in Kentucky, and also the Caves of Ajanta near Bombay, which have beautiful carvings on their walls executed over a thousand years ago, when they were used as monasteries and temples. In Great Britain, the caves of the Cheddar Gorge in Somerset, and of Clapham, in Yorkshire, are well known.

CELEBES, *see* EAST INDIES.

CENTRAL AMERICA. This is a region that is important because of its relation to the surrounding world rather than because of what it contains in itself. It is the narrow strip of land that joins the two continents of North and South America; it is also the slender barrier that separates the two oceans of the Atlantic and Pacific. It consists of the six independent republics (Guatemala, Salvador, Honduras, Nicaragua, Costa Rica, and Panama), the colony of British Honduras, and Mexico east of the Tehuantepec isthmus (*see* MEXICO). PANAMA (q.v.), which is in some ways rather different from the other states, is described in a separate article.

The map shows two things which are not generally realized about this strip of land. First, it lies north-west and south-east, and not from north to south. Thus, South America lies to the east of North America. A straight line up the Pacific coast of South America continues up the Atlantic coast of North America and passes through New York. Secondly, Central America is not a ribbon equally wide all the way down. It has a very irregular outline, narrowing and swelling again several times. Its most important bulge is the Yucatan peninsula, which juts out northward and divides the Gulf of Mexico from the Caribbean Sea.

Central America has along its whole length a mountainous backbone of high ranges with towering volcanic peaks. On both sides there are coastal plains, generally narrow but differing greatly. Westwards the mountains fall steeply to the Pacific coast, and the coastal lowland is well drained and healthy. Crops such as sugar-cane, maize, pineapples, and mangoes are grown. Eastwards the mountains fall less steeply, and a low shelving plain stretches to the Atlantic. The rivers bring down vast quantities of silt, and on the rich marshy ground behind mangrove swamps there is tropical forest and jungle dense with vivid green vegetation. Rubber and mahogany trees flourish. In the mountain valleys and on the lower slopes, the volcanic ash has weathered into very rich soil on which grow luxuriantly the usual tropical crops. Above 2,500 feet there are large coffee plantations and, especially in Guatemala and Honduras, enough cattle are bred to make the export of meat and hides an important trade.

Many of the towns, such as Tegucigalpa, the capital of Honduras, San José of Costa Rica, San Salvador of the little state of Salvador, and Guatemala of the state of Guatemala, are built inland on high ground. Guatemala is largely a new city, for it was rebuilt after the disastrous earthquake of 1917.

Managua, the capital of Nicaragua, is on the smaller of the two great lakes which lie on the Pacific side of the mountain range. The chief city of the colony of British Honduras is Belize, from which are exported large quantities of mahogany, bananas,

CENTRAL AMERICA

SAN CRISTOBAL, A VILLAGE IN GUATEMALA
Royal Geographical Society

...d coco-nuts. More interesting than the new ...ns are the remains of the cities and temples ... the old Maya Civilization (q.v. Vol. I), an American-Indian civilization flourishing long before Europeans came to Central America.

The mountain ranges, dense jungle, and marshy lowlands make land travel through Central America so difficult that it is much easier to reach most places in Central or South America from the United States by sea. Thus Central America is of less importance as a bridge between two continents than as a barrier between two oceans. One of the greatest changes of communications in modern times took place when the barrier was broken by the Panama Canal (q.v. Vol. IV), one of the great highways of the earth. It is strange to think that before it was built American ships could not go from New York to San Francisco without making the terrible Antarctic journey round Cape Horn, or alternatively going three-quarters of the way round the world past the Cape of Good Hope and across the Pacific.

See also Vol. I: Central Americans.

CENTRIFUGAL FORCE, *see* Motion.

CEYLON. Two of the native names for Ceylon are the 'Resplendent Isle' and the 'Pearl upon the Brow of India'. Certainly it would be difficult to find another country of its size so beautiful. In shape Ceylon is often compared to a pear, dropping into the Indian Ocean off the end of India (*see* Map, p. 229). The island is about five-sixths the size of Scotland, and has a population of about 6,700,000.

As Ceylon lies only about 400 miles north of the Equator, the climate at any one place on the island is very much the same all the year round. On the flat country in the northern half, and round the coasts, the temperature is generally around 85° F. (a very hot day in

CEYLON: LOOKING DOWN FROM A MOUNTAIN SIDE ON TO TERRACED FIELDS. *Royal Geographical Society*

England), and the atmosphere seems sticky and often oppressive. In the hills, however, 6,000 feet up, it is cool enough for fires in the evening, and frosts have been known. But in both areas there is little difference between winter and summer. The whole of the island has a very heavy rainfall, in places over 200 inches in the year—about four times as much as some of the rainiest parts of Great Britain.

There are three large rivers, all of them rising in the high country near a mountain called Adam's Peak. The longest river (206 miles long), called the Mahaweli, flows into the sea at Trincomali on the east coast. None of them is navigable by large boats. The mountains look very fine, with almost all the summits covered in jungle, and, lower down, plantation after plantation of low green tea-bushes. Adam's Peak (7,353 feet), the best known, is an impressive isolated cone. At dawn the sun throws its shadow for 40 miles over the flatter country to the west. On the top of it there is a rock bearing the imprint of an enormous foot. Buddhist legend has it that Buddha leapt into the air from this rock, and was carried up to Heaven. Hundreds of pilgrims climb Adam's Peak every year to 'acquire merit', walking there from all parts of the island. The highest mountain, Mt. Pedro, is 8,200 feet high—twice as high as Ben Nevis.

In the flat northern half of the island, and round the coasts, the jungle is so thick that only an axe can clear a pathway. Here and there in the jungle are swamps or large artificial lakes called 'tanks', built as reservoirs centuries ago, and still used. In other areas are plantations, with line upon line of coco-nut palms or rubber-trees. Many sorts of beasts live in the jungle, such as elephants, leopards, monkeys, crocodiles, cobras, and pythons, and many kinds of birds, including golden orioles, kingfishers, paroquets, and flamingoes, as well as rarer kinds, such as the red-vented bulbul and the white-bellied drongo. Most of the coast is flat, and there are beautiful sand beaches, very yellow against the deep blue of the sea.

Colombo (q.v.) is the main port of Ceylon, and Ratmalana, the main airfield, is close by. The natural harbour of Trincomali on the east coast is an important naval base. In the days of the Dutch, 200 years ago, Galle in the south-west used to be the main harbour; there is now a seaplane base close to it. Colombo is the only large town in the island; the next most important are Jaffna in the extreme north, and Kandy in the centre, the ancient capital of the 'up-country' Sinhalese, and famous for its Buddhist temples.

Rice takes the place of bread in the diet of the natives, and in the country nearly every family has a paddy-field. In the hills whole valleys have been converted into a series of carefully irrigated terraces, where individual fields may be no more than a few yards wide. There is good fishing round the coasts, though this is little developed.

Tea, rubber, and coco-nuts are the three great products and exports. Tea is cultivated mainly on the hills by European planters, and everywhere above 3,000 feet plantations extend for mile after mile, and tea factories (enormous three-storeyed buildings) are perched on the hill-sides. During the Second World War Ceylon was the principal supplier of rubber for the Allies—though normally it produces far less than Malaya. The coco-nut yields copra and coco-nut oil, and the resin from its bark is tapped to make a drink called toddy, which is distilled into arak, a powerful spirit.

n several areas, round the edges of the hills, ious stones such as sapphires and moon- ıes are found.

The country has a good railway system and an llent network of roads. Nearly every large ıge has an official Rest House, where ellers can stay comfortably and feed most ellently.

e also Vol. I: CEYLONESE.

IALCEDONY, *see* AGATE.

IALK, *see* LIMESTONE; OOZES; ROCKS, Sec- n 3.

CHANNEL ISLANDS. Jersey, Guernsey, lerney, Sark, and some smaller islets (of ich Herm, with 300 acres and 50 people, is largest) are situated in the Gulf of St. Malo the north-west coast of France. Alderney, northern isle, is about 60 miles from the glish coast and 8 miles from France; Jersey, southern island, is about 30 miles from St. lo. The total land area of all the Islands is ut half that of the Isle of Wight, but the ulation, about 94,000 people, is rather larger. Islands are rocky, rather like the coast of on, but they have a good covering of rich, tile soil. The capital of Jersey, the largest nd, is St. Helier, about the size of Weymouth. he capital of Guernsey is St. Peter Port, a rather maller town.

THE CHANNEL ISLANDS

The Islands are part of the British Isles (not a Colony or a Dominion), but they have a great measure of independence. They do not send Members to Parliament—and so Acts of Parliament do not apply to them unless the Islanders wish it. For the purposes of government there are two districts, called 'Bailiwicks'—Guernsey with Alderney, Sark, and Herm forming one, and Jersey the other. Each has a Lieutenant-Governor and a Bailiff. Jersey and Guernsey each has its own separate 'House of Parliament' called the 'States'. Sark is still a MANOR (q.v. Vol. X) with certain special rights, although the island is included in the Bailiwick of Guernsey. The States of the larger Islands make their own laws, raise their own taxes and customs, and carry on all the usual responsibilities of a government.

This form of government is the result of history. Before and after the Norman Conquest of England, the Islands were part of the Dukedom of Normandy, and were governed by representatives of the Duke, even after William the Conqueror became King of England. But when England lost her French possessions in the reign of King John, the Islands remained to the Kings of England as a vestige of their lost inheritance. From that time they have been treated as possessions of the King of England, but distinct from his kingdom of England; so that to-day the governments of the Islands are responsible to, and can be overruled by, His Majesty the King-in-Council. This, in effect, means that the control of the Islands lies with the Privy Council advised by the Home Secretary, instead of with the English Parliament. Throughout their history, therefore, the populations of the Islands have been privileged communities, and owing to the difficulties of communication in ancient times, the island authorities were able gradually to take possession of the King's administration by filling the various offices with Islanders. Thus the Bailiffs, who have always been Channel Islanders, have been able gradually to displace the King's Warden, and take on his authority themselves, so that each is now acknowledged as head of his own island.

This independence has resulted in the retention of many archaic laws and customs, which the Islanders have the right to modernize when they wish. Another result has been that, until quite recently, the language of the Islands was French. French is still the official language used

MONT ORGUEIL CASTLE GOREY, JERSEY. *Margot Lubinski*

for archives and in the ritual of the Courts and States, but by common consent debates are now held and business conducted entirely in English. A patois of French is still freely spoken in Jersey and to a lesser extent in Guernsey, but has disappeared from Alderney. Of course, all the Islanders can now speak English as a mother tongue.

Because of their southerly position, and of the influence of the Gulf Stream, the Islands have a climate somewhat milder than that of southern England and generally oceanic in character. They have, too, a generous allowance of sunshine—a good deal more than the highest recorded in England. Frosts are known, but are not common, and the winters are mild and rather wet. The summers are rather warmer than anywhere in the British Isles. Palm-trees grow there.

The Islands are not poor, and there is work for everyone. The inhabitants are employed, directly or indirectly, in services connected with the tourist industry, or with market-gardening (new potatoes, tomatoes, grapes, flowers), or with small-scale farming. In Jersey, early potatoes form the most important crop, and these are all grown in small holdings—rarely exceeding 30 acres. Glasshouse gardening is an important activity in Guernsey. In point of acreage grass for cattle-grazing is the principal crop in Guernsey, but for every man employed in open farming there are four working in greenhouses.

The Islands are famous for their special breeds of cattle: the small, delicately built Jersey cow with its low food-intake and high, rich milk-yield; and in Guernsey the rather larger brown-and-white Guernsey cow which also gives a very high grade of milk. The purity of these breeds has been maintained by rigorous laws. Since 1763 no cattle of other breeds have been permitted in the Islands. There are no Jerseys in Guernsey, or Guernseys in Jersey. The value of the herd lies, of course, in breeding for export—it is said that the breeds tend to lose their characteristics when bred out of the Islands for 40 or 50 years, so that there is a constant demand from overseas (*see* CATTLE, Vol. VI).

The tourist industry is of great economic importance to the Islands. The Islanders rely on the genial climate and exquisite scenery of the islands to attract visitors, rather than on organized beach entertainments and fun-fairs. British Railway steamers run regularly to the Channel Islands from Southampton and Weymouth, and British European Airways also maintain regular services.

[illegible]MISTRY is often described as 'the study [illegible]hat things are made of'. By 'analysis' it b[illegible]ks down various forms of MATTER (q.v.) into t[illegible] elements comprising them, and by 'syn[illegible]' it combines elements or other substances [illegible]h a way as to make other 'chemical com[illegible]ds'. The comparatively new study of what [illegible]lements themselves are made of is called [illegible]ic or Nuclear Physics (*see* ATOM). Organic [illegible]nistry deals with the substances produced [illegible]ving organisms, and also with certain com[illegible]ds which are similar to them in being [illegible]ly made up of carbon and hydrogen; [illegible]ganic Chemistry deals with all substances [illegible]taining only MINERALS (q.v.).

[illegible]emical compounds are not at all the same [illegible] as mixtures. If we mix sand and salt, for [illegible]nce, the mixture will still feel sandy and [illegible] salty; we can mix any quantity of the one [illegible] the other; and it is not very difficult (by [illegible]lving the salt in water and leaving the sand [illegible]d) to separate them again. In other words, [illegible]and salt do not form a new substance when [illegible] are mixed. But if we put a soft metal, called [illegible]m, with an evil-smelling gas, called [illegible]ine, under the right conditions, the two [illegible]ances combine to make quite a different [illegible]ance, familiar to us as salt (or sodium [illegible]ride), and not in the least like either sodium [illegible]lorine. Or if iron left out in the air becomes [illegible]p, we shall in time get a certain amount of r[illegible]st, which is quite unlike iron, water, or air, but is a chemical compound of the iron with oxy[illegible] from the air.

When elements combine to make a compound they always do so in exactly the same proportions by weight, and these proportions are related to their atomic weights (*see* MATTER). For instance, 18 oz. of water are always made from 2 oz. of hydrogen and 16 oz. of oxygen. The reason for this is clear when we study the 'molecules' of which every substance is made up. A molecule is the smallest part of any substance which can exist; it is made of atoms linked closely together. The molecule of an element contains one or more atoms of one kind only, but the molecule of a compound contains atoms of the different elements of which it is made. All the molecules of a compound contain the same number of atoms in the same proportion—for example, every molecule of water has 2 atoms of hydrogen and 1 atom of oxygen.

In writing down the [illegible] substances, chemists make use of a sort of shorthand called Chemical Symbols and Equations. Each element is shown by a symbol of one or two letters (generally its initial and one other). Thus hydrogen is H, oxygen O, chlorine Cl, sodium Na (from natron—an old name for carbonate of soda), iron Fe (Lat. *ferrum*). The full list is given in the Periodic Table of Elements with the article MATTER. The proportion of atoms of each element in a molecule is shown *after* the symbol for the element. Thus water is H_2O, salt NaCl.

The way in which elements can combine is decided by what is called their 'valency'. This can best be understood if one imagines each atom of any element to have a certain number of arms outstretched to grasp the arms of atoms of other elements: chemical combinations can only take place if exactly the right number of arms can link up to form each molecule of the new compound. Thus the valency of hydrogen is one, that of oxygen two: in a molecule of water

FIG. 1. MOLECULES OF HYDROGEN AND WATER

one atom of oxygen holds out its two arms and grasps the single arms of two atoms of hydrogen (Fig. 1). Some elements have two valencies. For instance, in ferric oxide (rust), a compound of iron and oxygen, the iron atoms act as if they each had three arms (valency 3) to link with the arms of the oxygen atoms; but in ferrous oxide (a black powder which is also a compound of iron and oxygen) they act as if they had only two arms (valency 2). Some elements, all of them gases, have no valency and can never form chemical compounds. They are therefore called the 'inert' (or inactive) gases.

It is only within recent years that an explanation for valency has been found. The atoms of all elements are now known to consist of yet tinier particles, called 'electrons', which may be thought of as circulating round a central core, the 'nucleus'. Valency is dependent on the number of these electrons—this subject is described more fully in the article on ATOM.

Carbon, an element which is found in all living things, forms very many more compounds than any other element. The molecules of some of these compounds contain exactly the same

atoms, and yet the compounds are different. There are, for instance, two different kinds of the paraffin called butane, the molecules of both having 4 atoms of carbon (valency 4) and 10 atoms of hydrogen (valency 1). The difference must be because the atoms are linked together

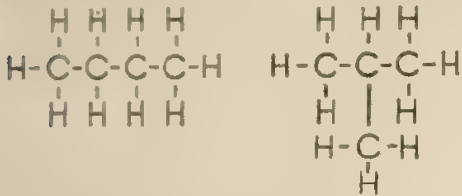


FIG. 2. MOLECULES OF TWO BUTANES
Though each contains the same number of carbon and hydrogen atoms they are linked together differently and so form different substances

in different ways (Fig. 2). So it is not always enough to know the atomic composition of a molecule: in some cases we must also know how the atoms are linked together.

There are different kinds of chemical actions. Substances can combine to form compounds—for instance, iron and oxygen make rust; compounds can be broken up—if sugar is burnt, hydrogen and oxygen are given off and a lump of black carbon remains; or the component parts of compounds can change places to form new compounds. This happens when washing-soda is put into water to soften it. The hardness is due to calcium bicarbonate, which reacts with the soda (sodium carbonate) to make calcium carbonate (the scum which forms on the top of the water) and sodium bicarbonate.

The atoms in a molecule are more or less closely linked together, and energy has to be exerted to make a chemical action take place. Sometimes chemical actions produce energy in the form of heat or an explosion. The explosion of gunpowder is due to the rapid expansion of gases produced by the chemical action which occurs when gunpowder is ignited. So much heat is produced when water is added to quicklime (making slaked lime) that it will burn the hands or clothes and, when used in gardening, must be kept away from plants.

Very few elements are found in a pure state in nature: most of them exist principally in the form of one of their compounds. METALS (q.v.), for instance, are with very few exceptions found as ores composed of a metallic chemical compound, with, of course, a certain amount of earthy matter as well. Sand is itself a mixture of various minerals, in all of which chemical compounds of silicon (Si) and oxygen play a large part. Clay contains a lot of aluminium silicate, a compound of aluminium (Al), silicon, and oxygen. The 'White Cliffs of Dover' are mostly made of chalk (or calcium carbonate, $CaCO_3$), a compound of calcium (Ca), carbon (C) and oxygen. One of the processes by which the surface of the earth is constantly being worn away is that of 'chemical weathering', which is described in the article on DENUDATION.

Chemistry, then, is very much more than the mixing of medicines in chemists' shops; it is more even than the huge CHEMICAL INDUSTRY described in Volume VII. The greatest chemist of all is nature itself, which never ceases to mix and combine, to break down or build up the elements of the universe in an infinite variety of chemical processes—not the least important of which are those which continue without pause in our bodies and in all living things, changing the nourishment which we get from food, and which plants get from the soil and the air, into flesh and bones, leaves and flowers.

See also Vol. VII: CHEMICAL INDUSTRY.

CHICAGO. This is the second largest city in the U.S.A. and has over $3\frac{1}{2}$ million inhabitants. It is the capital of the Middle West. To many its name suggests only stockyards and gangsterism. Chicago, like all great cities, has its sinister features, but they are a very small part of the whole. Its cultural activities are

CHICAGO: A BEACH ON THE SHORES OF LAKE MICHIGAN
Paul Popper

no:able. It has all the amenities of a great city, o: of the finest universities in the U.S.A., a c: opera house, a world-famous symphony o hestra, museums, and art galleries, and it has ed two great exhibitions, the Columbian osition or World's Fair of 1893, and another, d 'The Century of Progress', in 1933–4. The bition of 1893 has had a lasting effect upon erican architecture.

leat-packing is but one of its many indus- : it is equally famous for iron and steel and oad construction, and the name of Pullman, inventor of the sleeping-car, is as well known hat of Armour, the tinned-meat millionaire. hicago grew up from Port Dearborn, with pulation of 150 at the beginning of the 19th ury, to an ill-constructed town of 300,000 bitants in 1871. In that year the whole which was built largely of resinous pine, burnt to the ground. The Great Fire of ago—popularly supposed to have been ted by the cow of the Widow O'Leary, which a lamp—was, like the Great Fire of don, a blessing in that it made possible the ling of a very much finer city, a city whose tiful situation on the south-western shore of Michigan has not received the apprecia- which it deserves. The vitality and youth hicago have led the distinguished American r Carl Sandburg to speak of it as 'Laugh- the stormy, husky, brawling, laughter of th, half naked, sweating, proud to be hog butcher, tool maker, stacker of wheat, player ith railroads and freight handler to the nation'.

CHILE. The Ribbon Republic, as Chile has been called, runs in a narrow strip some 2,700 miles along the Pacific coast of South America (*see* Map, p. 415). A low range of hills runs close to the coast and is separated from the high mountain ranges of the Andes by a narrow plain often less than 50 miles wide. The frontier of Chile and Argentina lies along the Andes heights, usually some 15,000 to 18,000 feet above sea-level, but rising in its highest peak, Aconcagua, to 22,850 feet.

Northern Chile, where the country is widest, is part of the scorching Atacama Desert. This is an area very rich in mineral wealth, from which come nearly all the natural supplies of nitrate in the world. The extraction of iodine from nitrate of soda is an important industry. In the Andes to the west enormous quantities

A VIEW FROM THE COASTAL HILLS ACROSS THE FERTILE PLAIN OF CHILE TO THE HIGH ANDES
Dorien Leigh

of copper and other minerals are mined. All the main towns are on the coast. The mining camps inland have to be supplied from outside, not only with all their equipment, but also with every particle of food and water. Antofagasta, the chief town and port of this northern mining region, has large smelting-works.

In central Chile there stretches a great agricultural region. It has a Mediterranean type of climate, in which wheat, maize, oats, barley, and a great variety of fruits flourish. It was from this area that potatoes were taken to Europe in the late 16th century. The forests of the Andes yield enormous quantities of fine timber.

Farther south are cattle and sheep-lands, the sheep-lands extending to the wind-swept blustery region of the Strait of Magellan and beyond, with its fiords, snow-capped peaks, and glaciers that sweep right down to the sea.

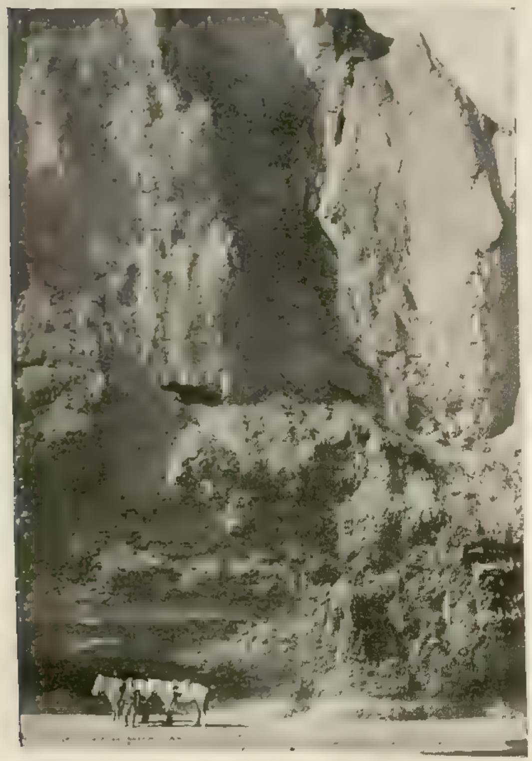
Chile has a population of nearly $4\frac{1}{2}$ millions. The capital is SANTIAGO (q.v.), a fine modern town, situated on the west slopes of the Andes. Valparaiso, rebuilt after a very destructive earthquake in 1906, is the chief port. So narrow

is the coastal lowland there that elevators carry people and goods from the port area to the rest of the city on a hill above. Punta Arenas, on the north shore of the Strait of Magellan, is the most southern town in the world, and its climate is cold and bleak. It is a wool centre and a woollen manufacturing town.

Chile owns many islands, more than any other South American State. In one of them, Mas-a-tierra, in the Juan Fernandez group, Alexander Selkirk, the original 'Robinson Crusoe', lived from 1704 to 1709. Easter Island, in the South Pacific, is a Chilean penal station, but is world-famous for its great stone figures and carvings, believed to be the work of early POLYNESIANS (q.v. Vol. I).

See also SOUTH AMERICA.
See also Vol. I: CHILEANS.

CHINA. This is indeed a country of contrasts —of high rugged mountains and flat alluvial lowlands, of vast barren deserts and swampy deltas, of rivers rushing through deep gorges and rivers winding sluggishly across flood plains, of primitive hoe agriculture and modern mining industrial centres. The people of the north are very different from those of the south—they look different, they speak different languages, and they eat different food.

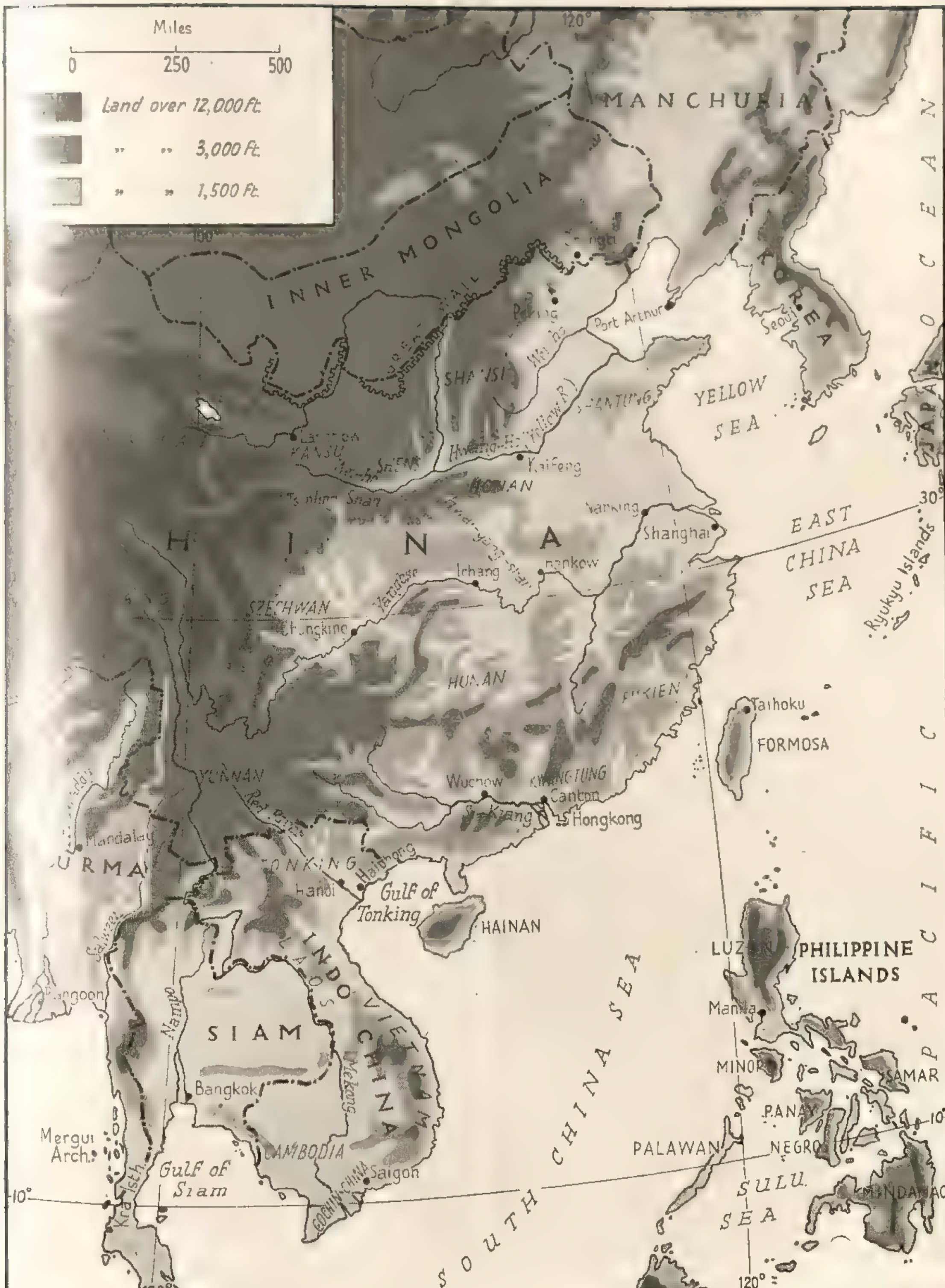


GREAT CLIFFS OF LOESS IN NORTH-WEST CHINA
Royal Geographical Society

The modern Republic of China consists of 'China Proper' and the 'Outer Territories' of Sinkiang, Chinghai, Inner Mongolia, and MANCHURIA (q.v.). A physical map of Asia shows western and northern China as part of the great highland of mountain ranges and plateaux which sweep eastward from the Pamir Mountains, sometimes called the 'Roof of the World' (*see* ASIA). Sinkiang in the extreme north-west is mainly a high desert plateau lying within the horseshoe of the Tien Shan (the Celestial Mountain) to the north, the Pamir Mountains, and the Altyn Tagh of northern Tibet. Chinghai and Sikang (the province of China Proper which is south of Chinghai) are geographically part of the great plateau of TIBET (q.v.), a plateau higher than the highest mountain in Europe. Inner Mongolia lies north of China Proper—that is, north of the GREAT WALL OF CHINA (q.v.)—and south of the Gobi Desert (*see* MONGOLIA). It is called 'The Land of the Long Grass' and is mostly prairie-steppe, the home of wandering Mongolian herdsmen, though the Chinese farmer with his hoe and plough is steadily moving into it.

Feng-shui is a much-used word in northern China. It means 'Wind and Water', and the Chinese use it to describe the superhuman forces that they believe to be the cause of all good and bad. Wind and water have been, and are, very powerful forces in shaping the land. The north-western provinces of Kansu, north Shensi, and Shansi are mainly high, rather broken plateaux covered by a vast deep mantle of loess, a fine, yellow, wind-blown deposit brought from the deserts to the north. Loess is soft and crumbly; and the trampling of men, horses, and camels, and the grinding of wheels cause roads to sink till they become the floors of canyons 20 or more feet below the bare treeless fields—so that travellers may journey for days without even seeing the surrounding country-side. In some parts the people live in cave-houses cut in the face of loess cliffs, with shelves, tables, and beds carved in the loess. Millet and wheat are the chief crops grown in this soil.

The wind carries the loess eastward on to the flat North China Plain. Travellers approaching



SOUTH-EAST ASIA

Shanghai (q.v.) by ship on a calm sunny day notice about 100 miles from the coast that the blue water of the China Sea is cut sharply across by a line beyond which it turns a muddy yellow. This astonishing change is caused by the yellow silt which the Yangtze-Kiang, or Yangtze River (q.v.), carries to the sea. Farther north the Hwang Ho, or Yellow River (q.v.), does exactly the same. These two rivers have built the vast ever-growing North China Plain. This plain is almost treeless and is farmed very intensively, mostly in small peasant holdings growing millet, wheat, and soya-beans. Two blocks of mountains rise above it. The high rocky peninsula of Shantung juts out eastward into the Yellow Sea; and in the south-west the Hwai-yang-shan curves south and east, north of the lake-studded plain which is called the Central Basin of China.

West of the southern part of the North China Plain there is a region of high mountains, plateaux, and fertile river valleys. The greatest of the plateaux is the Red Basin of Sze-chwan. It is about five-sixths the size of Great Britain and is probably an old lake bed. Its fertile, well-watered floor of red clay is a great rice-growing area, and supports about forty-five million people. In the early 13th century Marco Polo visited its capital, Cheng-tu, and found its merchants handling a quantity of merchandise 'past all belief'.

TERRACE CULTIVATION IN THE MOUNTAINS OF YUNNAN, SOUTH-WEST CHINA

North China has a monsoon climate. In winter, dry cold winds sweep south from the cold plateaux in the north, and Peking (q.v.), which is in the same latitude as Rome, is as cold as Moscow. In summer, hot moist winds blow from the Indian Ocean—and Peking becomes as hot as the Nile valley.

The southern states of China are very hilly and mountainous, the only large plain being the delta of the Si-kiang River (q.v.), west of Canton (q.v.). Many of the rivers which flow southwards into the South China Sea, however, have broad flat valleys in their lower courses. The climate of southern China is sub-tropical and there is an abundant supply of water. Consequently there is a rich natural vegetation of forest and bamboo. China tea comes from the hills, and this area is also the home of the silk industry. Rice is the main food crop, and paddy-fields are everywhere—on terraces on the hills as well as in the valleys.

The animals also of southern China differ from those of the north. In the north there are horses, or rather ponies, which are brought in herds from the Mongolian plateaux where they are bred by the Mongols (q.v. Vol. I), and where alone in the world the true wild horse survives. The Bactrian camel with his two humps and long fringes of hair is reared on the northern steppe, and is used for the caravans which still make the long 9-month journey to the trading markets of central Asia. In southern China there is a great variety of animals, including monkeys and tigers in the jungles of the extreme south. In the mountains of the China–Tibet frontier there are found the panda and the giant panda, and several of the most beautiful varieties of pheasant in the world.

The northern and western barrier of mountains, plateaux, and deserts has throughout history cut China from the west, and has never been pierced by a railway; and China's only rail link with Europe is by the Trans-Siberian Railway (*see* Vol. IV: Railway Systems). Except for motor traffic on the new Burma Road (q.v. Vol. IV), land traffic between China and the Middle East still follows the same desert roads and mountain passes over which the silk caravans toiled in the days of ancient Rome.

But though China is a land of peasant farmers, and is likely to remain predominantly a land of peasant farmers, nevertheless in the last twenty years great industries and mining areas have

RICE-FIELDS NEAR CANTON IN WINTER

developed. In north China, under the loess deposits of Shansi, there are coal and anthracite. In south-west China there is great mineral wealth of tin, wolfram, molybdenum, zinc, lead, copper, antimony, and mercury.

China has many large towns. PEKING (q.v.), the ancient capital, is situated at the northern edge of the North China Plain. NANKING (q.v.), the modern capital, is on the Yangtze River. CANTON (q.v.) is the biggest city in southern China, and a great trading port. SHANGHAI (q.v.), another very important port, had a large international settlement; while HONG KONG (q.v.), on an island on the east side of the mouth of the Si-kiang, is a big British naval base.

See also Vol. I: CHINESE CIVILIZATION; CHINESE PEOPLES.

CLAYS AND SHALES. A rock which becomes plastic and muddy when wet is called a clay. A clay is, in fact, merely a consolidated mud. When examined under a microscope its particles are too small to be clearly distinguished. Indeed, they are so small that, in past times, they were carried in suspension by rivers and finally deposited in lakes or shallow seas. The sort of material which makes clays can be seen along the banks of an estuary at low tide. Clays are often rich in decayed plant and animal remains, and this gives them a blackish or greyish colour; but clays exposed to air usually turn brown, owing to the oxidation of the iron compounds (largely iron sulphide) derived from the organic matter.

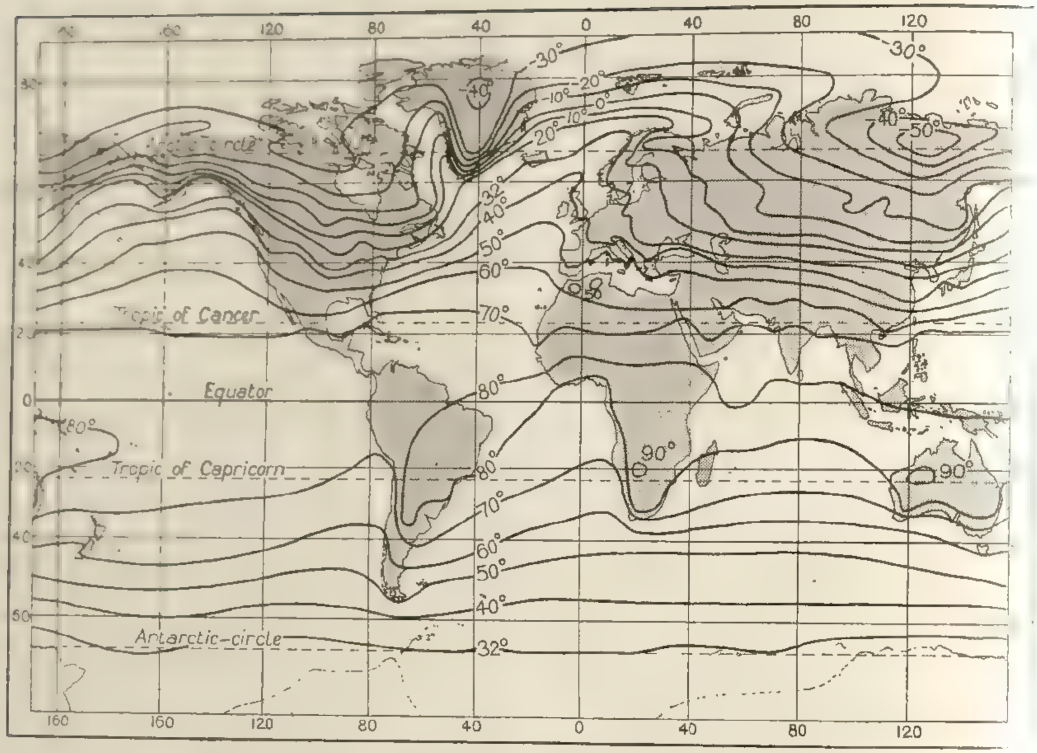
If a clay has been laid down in layers which easily break apart into biscuit-like fragments, it is called 'shale'. Some shales have been formed from mud very rich in decayed organic matter, and are so oily that they readily ignite from a match flame (for instance, the shales at Kimmeridge Bay in Dorset). Such shales are called 'oil shales'. Some can be used for the extraction of oil; but most of them contain so much sulphur that the cost of removing this impurity would be more than the value of the oil (*see* OIL, NATURAL).

'Marl' is rock consisting partly of clay material and partly of calcium carbonate. For 'red clay' *see* OOZES.

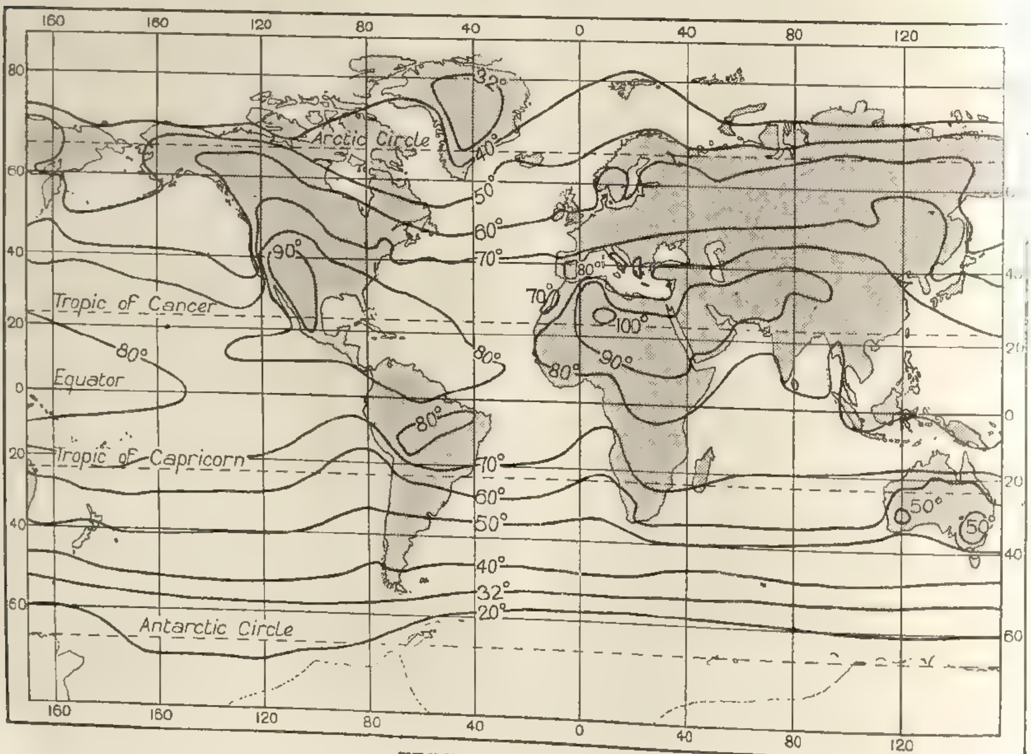
See also DENUDATION; ROCKS, Section 3 (*b*), (*c*), and (*e*).

CLIMATE. 1. Although man has learnt with the help of science to control his environment to a great extent, his life is still very much influenced and conditioned by the climate he lives in.

Climate decides what clothing the people of a region wear. The people of the far north wear furs and wool because the climate is cold; and these materials are available because the animals also need warm coats. In hot countries the people wear cotton and silk, which are cool and can be easily produced in hot climates. In the



JANUARY TEMPERATURES IN °F.



JULY TEMPERATURES IN °F.

hottest parts of the world clothing is not necessary at all, and the natives only wear what they want for decoration. Climate also decides the type of houses the people live in—houses with steep roofs off which the snow will fall easily, houses with flat roofs and wide verandas to give protection from the sun, or tents which can be easily moved when the people have to move after fresh pastures. The staple food of a country is, generally, what can most easily be grown there or most easily be procured. Eskimoes eat seal-meat and fish, British and Americans eat beef, mutton, and pork, and grains such as wheat and oats. The peoples of southern Asia eat rice, and desert people eat dates and olive-oil. British people eat apples and drink beer, while people in the south of France eat grapes and drink wine. All these matters are directed mainly by the type of climate to be found in the different countries.

The temperature of the air depends mainly on the amount of heat received from the sun, and this is ruled by two things, the intensity of the rays and the length of time they are being received. The article on EARTH explains how the sun's rays strike vertically—and so most hot—at the Equator all the year round, and how the effect of the different seasons of the year increases as the Poles are approached. If latitude, or distance from the Equator, were the only factor in deciding air temperature, the climates of the world would grow increasingly cold as the distance from the Equator increased. Indeed, this does, in general, happen, for latitude is extremely important in deciding climate; but there are other factors, of which distance from the sea is the second most important. This affects both temperature and rainfall. Water heats up much more slowly than land, but holds heat much longer, and so temperatures near the sea tend to be lower in summer and higher in winter than those of inland places of the same latitude. The third major influence on air temperature is altitude, or height above sea-level. As everyone who has climbed a mountain knows, the air gets colder as the top is neared (*see* ATMOSPHERE). It has been calculated that each rise of 300 feet means a drop of about 1° F. in temperature. This lowering of temperature means that places at high altitudes are much cooler than those near sea-level. This is very important, for on the high plateaux of South America and Africa white people are able to live healthily at latitudes which would be impossible for them were the country at sea-level.

Relief influences climate also. In India the Himalayas keep out cold winds from the north. In Canada and the United States of America, where there is no such protecting highland, icy winds often blow southwards as far as Florida, lowering the temperature by many degrees. Again, north of the Equator the northern slopes of the east–west valleys have a less rigorous climate than the southern, because they get the full benefit of the sun. For example, holiday resorts along the south coasts of England and France benefit from facing south.

Rainfall (*see* RAIN) is measured in inches (or millimetres) per month or year, the figure also including sleet, SNOW, HAIL, and DEW (qq.v.). But to judge the climate of a place more fully we should also know the number of rainy days and the intensity of the rain-storms. Steady, persistent rain does much more good than heavy downpours, because it penetrates deeply into the soil, instead of running off or being evaporated in the fair intervals between the downpours. Climate tables show, also, whether the rain falls in summer, when a lot will evaporate, or in winter.

2. CLIMATE TYPES. Climates can be grouped by temperature differences into five main kinds:

(*a*) Hot climates, in which the mean annual temperature is over 70° F.

(*b*) Warm climates, in which the mean monthly temperature never falls below 43° F.

(*c*) Cool climates, in which there is a cold season of up to 5 months, when the mean monthly temperature falls below 43° F.

(*d*) Cold climates, in which for 6 or more months the mean monthly temperature falls below 43° F.

(*e*) Arctic climates, in which there is no warm season, for the temperature never rises to 50° F.

When rainfall also is taken into account, these five groups can be divided into climate types.

(*a*) *Hot Climates* are of three main kinds: 'equatorial climates' which have rainfall all year, 'tropical climates' which have little or no rain in winter, and 'desert climates'.

Equatorial climates, as their name implies, are found along the Equator. Temperatures are always high, and as this is the belt of the Doldrums or calms (*see* WINDS), rainfall occurs regularly, falling daily in heavy THUNDER-

STORMS (q.v.), often about four o'clock in the afternoon.

Tropical climates occur north and south of equatorial climates, generally speaking, within the Tropics of Cancer and Capricorn. Again temperatures are always high. In summer they are in the Doldrum belt, and then they have heavy rain. In winter they are in the Trade Winds belt. Except along eastern coasts where they are blowing on-shore, Trade Winds are dry winds. Along eastern coasts there is found the maritime tropical climate with rain all year, but with much more in summer than in winter. Inland and west-coast regions have a continental tropical climate, a much more common type, which has no rain in winter. A special type of tropical climate is the MONSOON (q.v.), to be found chiefly in India, Indo-China, Siam, and the Philippines.

Hot DESERTS (q.v.) lie in the Trade Winds belt all year, and are found in North Africa (Sahara), South Africa (Kalahari), Arabia, India (Sind), Australia, North America (southern California), and South America (Atacama).

(*b*) *Warm Climates* are sub-tropical. In summer they are within the Trade Winds belt and have a tropical climate. In winter they are in the belt of westerly winds. They can be divided into 'Mediterranean climates', such as are found on western shores, and 'eastern margin' warm climates.

Mediterranean climates, which are typical of the countries bordering the Mediterranean Sea, also occur on the western shores of all the continents—in California, Chile, Cape Town, and south-west Australia. Summers are hot and dry, for the Trade Winds bring no rain; winters are mild and wet, for the westerly winds are rain-bearing winds. Snow is rare, except on the higher mountains.

In the Mediterranean area the onset of cyclones is accompanied by winds which come from the deserts of North Africa and are hot, dry, and dusty. In Algeria they are called the SIROCCO (q.v.); in Spain, the *Leveche*; in Egypt, the *Khamsin*. In California similar winds come from the desert in the south and are called the *Santa Annas*. The end of cyclones also, in the Mediterranean, is marked by winds, the northerly MISTRAL (q.v.) of the south of France, and the *Bora* of the Adriatic.

Eastern Margin warm climates also have mild winters and hot summers, but have rain all year, since it is brought both by the westerly winds and by the on-shore-blowing Trade Winds. Climates of this type occur in south Brazil, Argentina, and Uruguay, in the states of the U.S.A. bordering the Gulf of Mexico, in Natal in South Africa, and in New South Wales in Australia. Cyclones and HURRICANES (q.v.) are fairly common. The cyclones are accompanied by rapid changes in temperature and by strong winds, such as the 'Southerly Burster' of New South Wales and the 'Norther' of the U.S.A. High temperatures combined with a great degree of moisture make the summers so tiring that white people can do little manual labour.

A special type of sub-tropical climate is the MONSOON (q.v.) type, experienced in central and southern China. It is characterized by very cold winters, and by the large number of tropical cyclones or typhoons experienced (*see* HURRICANES).

(*c*) *Cool Climates* differ from each other mainly according to their distance eastwards from the sea. The farther eastwards from the sea the greater is the difference between summer and winter temperatures, the lower the rainfall and the less evenly distributed throughout the year. The sea, the warm westerly winds from it and, in Europe, the warm North Atlantic Drift (*see* OCEANS) tend to modify the climate of western coasts, keeping temperatures up in winter and down in summer, compared with those of inland areas of the same latitude and altitude.

On western coasts the rain is distributed fairly evenly throughout the year. Farther inland rain occurs mainly in summer, as it is then that conditions are most favourable for convectional rain. Snow occurs everywhere, though in the more southern parts it probably lasts only a few days.

The maritime type of cool climate is experienced in the British Isles, western Europe, on the west coasts of northern U.S.A. and southern Canada, in southern Chile, and in New Zealand. Eastwards in Europe and in North America the climate changes to the continental type with greater extremes of temperature and scantier rainfall. Eastern North America has a special type of cool climate caused by winds from the south and west, which bring rain in winter to an otherwise continental climate. Also, in summer, cyclones bring weather of great heat and humidity, to the great discomfort of the city-dwellers of the big cities inland from the east coast.

Another type of cool climate is the monsoon type of eastern Asia. In China, in the great plain and the peninsulas to the east of it, cold dust-laden winds sweep down in winter from the icy deserts of central Asia. This is a season of practically no rain except in the north, where there is snow and severe blizzards. Summer comes very suddenly, and the south-east monsoon wind sweeps inland bringing heavy cyclonic rain.

(b) *Cold Climates*, like cool climates, vary in intensity with distance from a western seaboard. Unfortunately, in both Europe and North America mountain ranges lie close to the west coast, and parallel to it, so that the moderating influence of the sea does not extend far inland, and the rain-bearing westerly winds lose much of their moisture on the coast ranges.

The maritime type of cold climate is often called the Norwegian type, as it is found there. The continental type is the Siberian climate. Winters are extremely cold, but, as the atmosphere is very dry, the coldness is not unpleasant to man. Animals often hibernate. Movement is by sledge, for rivers and marshes are frozen.

(c) *Arctic Climates* occur in northern Alaska, Labrador, and northern Siberia. In 'tundra climates' summer temperatures rise above freezing-point, and snow disappears for a stretch of time sufficiently long for grasses, lichens, and mosses to grow. Farther north there is no summer and no vegetation grows. Man can live in tundra climates, but not in the region of perpetual frost.

See also WEATHER.

CLOUDS. 1. CLOUD FORMATION. Clouds are formed when the amount of WATER VAPOUR (q.v.) present at any level is greater than the air can hold, the atmosphere being then said to be 'saturated' or above 'dew-point'. They are, in fact, similar to the steam which we see coming out of the spout of a boiling kettle; but whereas this quickly evaporates and is absorbed by the unsaturated air of the kitchen, the tiny particles of water forming a cloud cannot evaporate, because the air around them already contains all the water vapour it can hold. Warm air can hold more water vapour than cold, and the most usual circumstance leading to the formation of cloud in the sky is that a body of warm air is cooled down to below the temperature at which it is saturated. When we breathe out on a cold day, for instance, our warm moisture-laden breath, which is not saturated at the temperature of our lungs, quickly becomes so as it is cooled by the air, and the excess of water vapour in it condenses and becomes visible till it is dispersed and evaporates again.

There are several ways in which warm air may be cooled in the sky. Owing to WEATHER conditions (q.v.) it may be brought into contact with a body of colder air, which will, of course tend to cool it. Or it may be raised to a greater height. The reason why this cools it is that, as it rises, the pressure on it becomes less and it therefore expands—and, in expanding, it must lose heat, just as the air suddenly let out of a bicycle tyre feels very cold (*see* PRESSURE). This loss of temperature on rising and expansion must not be confused with the gradual decrease in temperature at higher levels due to the air's increasing distance from the warmth of the earth's surface (*see* ATMOSPHERE). Air will rise for two causes. Firstly it will rise when it is pushed upwards. We see illustrations of this in the clouds that so often hang over mountains. What happens is that the damp wind from the sea strikes the mountain-sides and is forced upwards to a height where it can no longer hold its moisture, and so this is precipitated as cloud or rain. That is why hilly districts like Cumberland have a higher rainfall than flat country. A mass of cold air (or 'cold front' as it is called by weather experts) can act in the same way as a mountain if a warm wind meets it. Secondly, air will rise when it is warmer, because the heat having expanded it, it becomes lighter (*see* HEAT, Section 3). It is then said to rise by 'convection'. In this case, the varying amounts by which air is warmed depend largely on the nature of the earth's surface beneath it, for the sun's rays have little power to warm the air until they have been reflected back from the earth. Some surfaces, such as sand, chalk, rocks, roofs, roads, and short turf, reflect back a lot of heat; others, such as vegetation, trees, and, especially, water, reflect back far less. So the air above the former group tends to become warmer and to rise above that of the latter. If the air contains enough moisture, clouds form as it rises. When its loss of heat brings its temperature down to that of the surrounding air, the movement ceases.

But condensation and evaporation also affect (and in opposite ways) the temperature of air

in which they take place. When a gas liquefies (or again, when a liquid freezes) it needs less energy in its new less movable state, and it gives up its surplus energy in the form of 'latent heat'. With the reverse process, evaporation, from liquid to gas (or thawing, from solid to liquid), the opposite happens, and heat has to be taken in: so the surrounding temperature drops (*see* Heat, Section 5). As our warm moist air rises, then, and its water vapour condenses into cloud, two opposing changes are at work: because it has expanded on rising, it has lost heat; but because of the condensation, it has gained heat. Its subsequent behaviour and the future of the cloud depend on the balance reached between the loss and the gain. Examples of this process at work are given in the articles on Thunder-storms and the Föhn wind (qq.v.).

The question arises why, if clouds are made of tiny particles of water (or, as we shall see, of ice) they do not fall down out of the sky. The reason is that such small droplets, measuring only about a hundredth of an inch, fall so slowly that the rising convection currents are strong enough to hold them up—the currents are, in fact, strong enough to lift a glider hundreds of feet a minute. Some of the larger particles in a cloud may escape the rising currents and drift downwards; but as they descend, they may get into warmer air again, and in any case Pressure (q.v.) upon them increases, raising their temperature, so that they evaporate. Though a cloud may look unchanged to us below, in fact the particles forming it are continually being renewed.

2. Cloud Types. Clouds are divided into four main types: 'cirrus', commonly known as 'Mare's-tail' or 'paint-brush'; 'stratus' or cloud-sheet; 'cumulus' or cloud-heap; and 'nimbus' or low, ragged, and shapeless cloud which gives us most of our rain and snow. Meteorologists divide them further, making ten types, according to their heights and the way in which the main types are combined. The High Clouds are 'cirrus', 'cirrocumulus', and 'cirrostratus'. They are found at heights from 25,000 to 35,000 feet, very rarely any higher. The Middle Clouds, known as 'altocumulus' and 'altostratus', range from 10,000 to 25,000 feet. The Low Clouds, found at any height up to 10,000 feet, though usually below 7,000, are 'stratocumulus', 'stratus', 'nimbostratus', and 'cumulus'. One last, 'cumulonimbus', the towering thunder-cloud, may stretch through all these levels at once.

Cirrus clouds (Fig. 1) look like wisps of hair, and lie 4 to 5 miles up, at which height the temperature is always below freezing-point, so that these clouds consist always of ice. Sailors believe that cirrus in a blue sky foretells windy weather, and this is probably true, though if the cloud thickens and turns into cirrostratus, it may mean that a depression bringing rain with it lies anything up to 1,000 miles away and is liable to move nearer.

Cirrocumulus (Fig. 2) looks rather like the ripples in the sand on the sea-shore. It is often seen at the approach of fair weather after a depression. One form of cirrocumulus is the well-known 'mackerel sky'. Cirrostratus is a thin whitish veil, which does not blur the outline of the sun or moon, but gives rise to 'haloes' (*see* Rainbow). The appearance of this cloud means that rain is on the way—though, especially in summer, it may never reach you.

Altocumulus (Fig. 3), the first of the Middle Clouds, are layers or patches of blob-shaped clouds arranged in groups, in lines or waves, with lanes in between. Faint rainbow colourings can sometimes be seen along their thin edges, and sometimes a 'corona' (*see* Rainbow) round the sun or moon. In summer this cloud can often be seen in late evening or early morning; but it tends to disappear in the heat of the sun.

Altostratus (Fig. 4) is a veil of even, grey cloud through which the sun can be seen dimly. It gives a typical 'watery sky' and is an almost certain sign of rain, because it is usually caused by a current of warm moist air flowing up over a 'cold front', as described above (*see* Weather). Stratocumulus, the first of the Low Clouds, is simply a lower and heavier form of altocumulus.

Stratus is the lowest type of cloud, often blotting out all high ground. Many mountaineers and hikers have got into difficulties through the sudden appearance of this cloud. It is apt to be very persistent, and may thicken and turn to Fog (q.v.), drizzle, or rain.

Nimbostratus, the cloud which gives us most of our heavy rain, also hangs low, often with tatters of 'scud' trailing below its base. It is dark grey and threatening.

Cumulus (Fig. 5) are heavy, cauliflower-shaped clouds with flat bases. They are formed

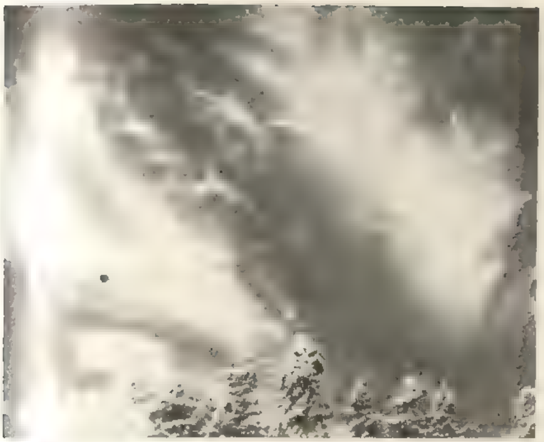


FIG. 1. CIRRUS

FIG. 2. CIRROCUMULUS

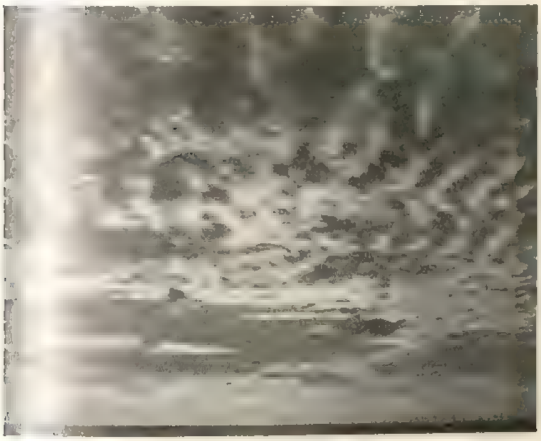


FIG. 3. ALTOCUMULUS

FIG. 4. ALTOSTRATUS

FIG. 5. CUMULUS

FIG. 6. CUMULONIMBUS

CLOUDS. *C. J. P. Cave*

by convection currents of rising air, warmed by reflection of heat from the earth's surface as already described.

Cumulonimbus (Fig. 6) is also a convectional cloud, but one which, towering up to a far greater height than the cumulus, builds up inside itself a mass of condensed water-vapour which often comes down in torrents of rain or HAIL (q.v.), accompanied by lightning and thunder. It is the thunder-cloud of hot, still summer weather (since anything more than a light breeze would disturb the convection currents); or, in spring or winter, it may bring sleet or snow. The currents of air in such clouds may be so strong as to be of great danger to aircraft.

COAL is an impure form of carbon derived from the remains of buried plants. It occurs in layers, usually less than 6 feet thick, called 'seams'. These seams are separated by varying thicknesses of shales and sandstones, the whole being known as 'coal-measures'. Under each seam of coal there is usually a bed of lighter coloured rock, which, because of its heat-resisting properties, is known as 'fire-clay'.

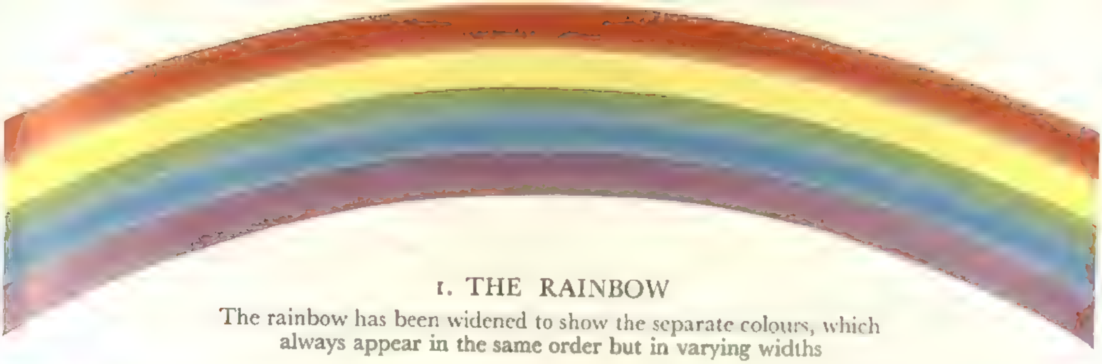
A FOSSILIZED FERN OF THE CARBONIFEROUS AGE
Professor J. A. Douglas

This is undoubtedly the remains of the soil in which the plants originally grew, for it sometimes contains fossil tree roots. The greater part of the world's coal was formed in Carboniferous ('Carbon-bearing') times; but in Spitzbergen and Bear Island in the Arctic there are also coal-beds of the Devonian, Jurassic, and Eocene Ages (*see* EARTH, HISTORY OF, Chart).

Coal was formed as a result of periods in which the land sank a little. The trees of the forests were first tumbled over by advancing water, and then buried by the mud and sand carried by wide rivers. Had there been no covering of mud and sand, coal would not have been formed, for most of the organic material, left exposed to air and water, would have rotted and been washed away.

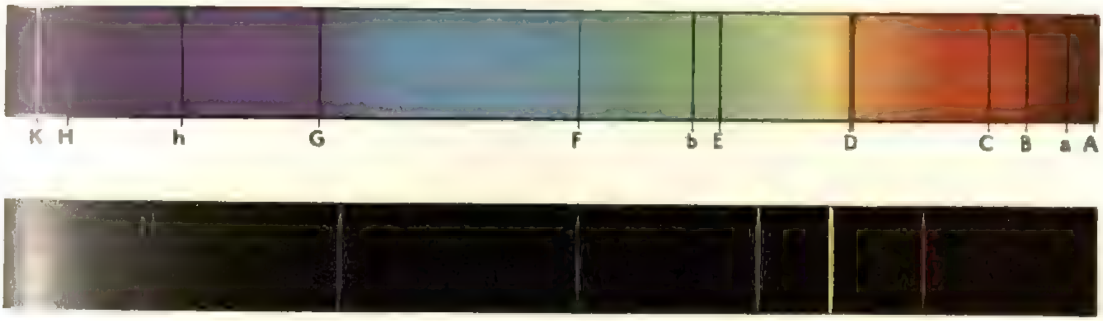
The first stages of coal formation must have been like 'peat', which is merely the compressed remains of plants growing in bogs. 'Lignite' (Lat. *lignum*, a log) is fossil wood at an early stage, in which plant structure is often visible; when it is not, lignite may be called 'brown coal'. 'Cannel (i.e. candle) coal' has been formed from areas of water-plants: it contains fish remains, and has sufficient tarry matter to make it ignite very easily and burn with a candle-like flame. Normal coal has undergone much more change and has lost more of the oily or tarry parts of plant remains. 'Anthracite', the hardest form of coal, owes its nature to great pressure and probably to heat: less than 5 % of it is ash and tarry matter, the rest being pure carbon.

Coal-seams have yielded such abundant plant and animal FOSSILS (q.v.) that we can form a very clear picture of the tropical forests which were their origin. The tallest trees were ancestors of our conifers, or cone-bearing trees, such as the pine; but their branches bore long strap-like leaves instead of needles. There were giant ferns and seed-ferns growing as high as the trees of to-day. The seed-ferns looked like ferns; but they were not ferns, because they formed seeds instead of spores—some seeds being as large as hen's eggs. Other seed-ferns grew as dense bushes. There were two other forms of tree which to-day are represented only by very modest and obscure descendants—horse-tails and club-mosses. Horse-tails grew 50 to 60 feet high, and club-mosses reached a height of a hundred feet. Horse-tails to-day are seldom taller than 5 or 6



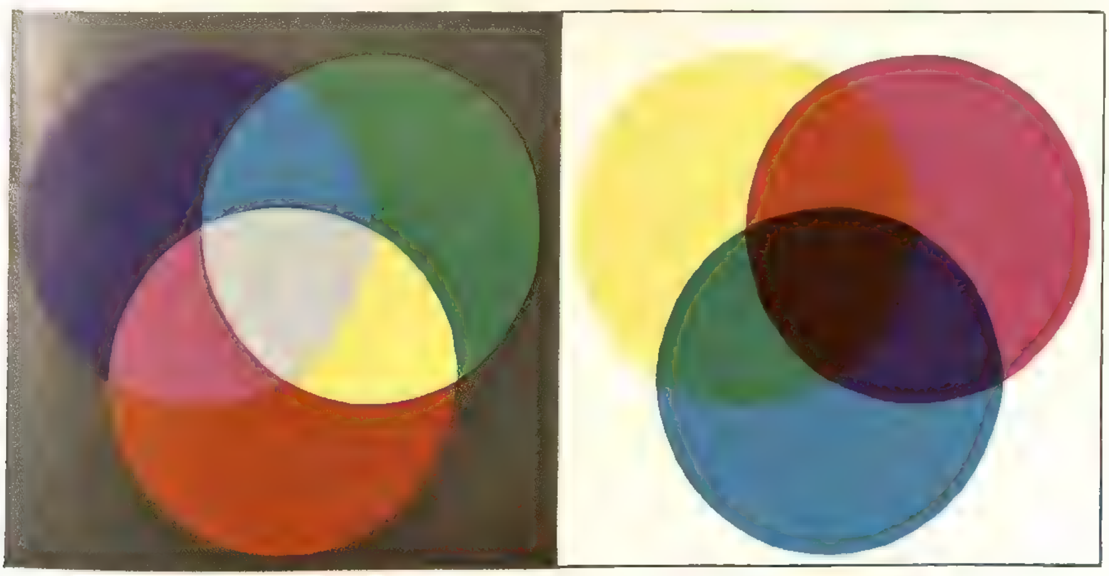
1. THE RAINBOW

The rainbow has been widened to show the separate colours, which always appear in the same order but in varying widths



2. SPECTRA OF THE SUN AND MERCURY ARC

The Solar Spectrum has its colours in the same order as the rainbow. Elements in the sun's surface and the earth's atmosphere absorb a part of the spectrum and cause the dark lines A, a, B, &c. If an element is heated to incandescence, it gives out light of characteristic colours at different parts of the spectrum. The characteristic spectrum of mercury arc is as shown here



3. THE PRIMARY COLOURS OF LIGHT AND PIGMENTS

On the left are the three primary colours of light. Where two overlap, they give the complementary colours, and all three together give white (or pale grey) light. The primary colours of paints are complementary to the primaries of light, and when they are mixed together, the result is dark grey

Drawn by Peter Hood

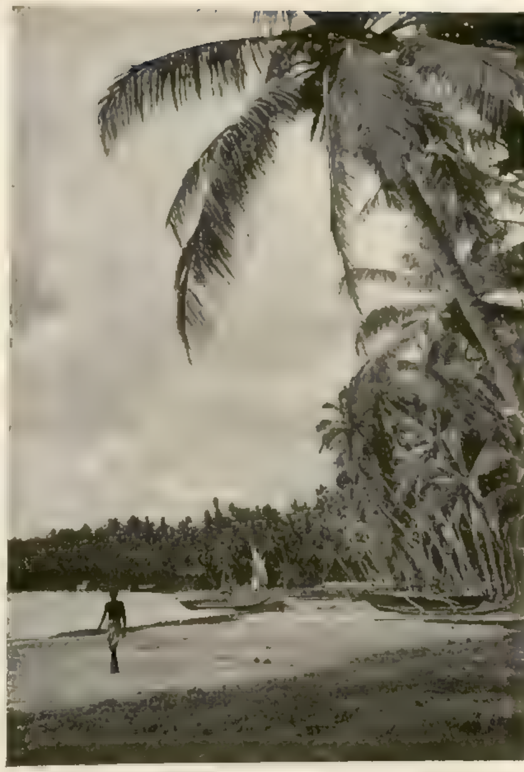
feet, while club-mosses rarely rise more than a few inches above the soil. Winding round these strange tree-trunks and bushes were climbing plants of all kinds, filling the forest with dense luxuriant green; while on the swampy soil, rooting stems clad with mosses and liverworts sprawled in all directions and were crawled over by strange amphibious creatures in search of insect food.

The slimy forest swamps teemed with all kinds of amphibious life, capable of breathing both in air and in water, some with long snouts, like those of alligators, specially suitable for catching fish. Some resembled fat newts; while others were like huge frogs 7 or 8 feet in length. Fish and freshwater mussels lived in the deeper swamps. On drier parts of the forest floor there were many types of wingless beetles, both large and small, scorpions, mites, spiders, centipedes, and even a few land snails. And there were the first of the reptiles—small insignificant creatures at this time.

There were great numbers of net-winged insects, many of them of enormous size (one kind measured nearly 30 inches across the wings). But the teeming life of these tropical forests was without the chirp of a bird or the bright colour of a flower, for neither birds nor flowers had yet appeared on the earth. However, many of the insects probably had bright colours, and the leaves and the forest floor may often have been covered with golden pollen dust from the trees. From such forests the modern world got its first great source of energy—coal—a kind of fossil sunshine.

See also EARTH, HISTORY OF; MOUNTAIN BUILDING; ROCKS, Section 3 (*e*); JET; FOSSILS.
See also Vol. VII: COAL-MINING.

COASTS. The coasts of the Earth are constantly changing: some are being attacked and worn away by the sea; others are being added to by rivers depositing silt in the form of deltas and mud-banks (*see* RIVERS); others are being altered by currents and winds; and some are being changed by slow land movement (*see* MOUNTAIN BUILDING). On the whole, a process of evening-out is taking place, for headlands and projections tend to be worn away, and bays to be filled with the material carried off. Sometimes, however, an island or a reef lies in the path of the material worn from headlands; and then the rock, pebbles, and sand are deposited,



A LOW, SANDY COAST IN CEYLON
B.O.A.C.

forming in time, perhaps, a causeway to the mainland.

Coasts may be grouped into flat, low-lying coasts, and high coasts, rising fairly steeply above the sea.

There are many kinds of flat coast. The simplest type has a gently-sloping beach of pebbles and sand, and usually occurs in wide bays separated by low headlands. The North Sea coast of England and part of the Atlantic coast of the United States of America are of this type. 'Lagoon coasts' have sandy ridges or spits parallel to the shore, but separated from it by a long lake or lagoon. These coasts are a feature of West Africa, and are found, too, in Holland, Germany, and Poland, as well as near the mouth of the Po in Italy, and in the Gulf of Mexico. In West Africa lagoons are often used by ships as shelter. Many of the European lagoon coasts have been drained and reclaimed for agriculture. The city of VENICE (q.v.) is built on the islands of a lagoon at the north of the Adriatic Sea. 'Mangrove coasts' are a type of flat coast found in tropical countries. This is a swamp coast,

CLIFFS AT BUDE, CORNWALL
British Council

usually flooded by tides, and rendered almost impenetrable by the twisted roots of the mangrove trees. Such types are found on some of the islands of the East Indies, and on the tropical coasts of East and West Africa and South America.

Of the high coasts, cliffs are the simplest type, though sometimes the force of the waves has formed CAVES (q.v.) and left off-shore rocks. When a coast is flooded by the sea, the type of coast resulting will vary according to whether the land has sunk or the sea has risen. In Brittany and south-west Ireland, for instance, the sea has flooded former river valleys and their tributary valleys, and the coast is marked by many islets and inlets. On the Dalmatian coast of Yugoslavia, on the other hand, the sea rose and flooded over an area of ridges into the valleys behind. The ridges then were cut off from the mainland and formed long narrow islands, separated by channels running parallel to a shore with long narrow bays.

Other high-coast types are found in glaciated country. If the GLACIERS (q.v.) once descended almost to the present shore, there are long, narrow, and deep inlets which are often a continuation of a U-shaped VALLEY (q.v.). These inlets, called 'fiords', are often deeper than the sea-floor off-shore. Norway, west Canada, southern Chile, the South Island of New Zealand, and north-west Scotland have fiord coasts. Another type of glaciated coast is well illustrated in Finland, where the numerous islands are the summits of the hills of boulder-clay country (*see* GLACIATION).

Coral coasts are characteristic of the Pacific Ocean. In some places the coral forms reefs or long barriers some distance from the shore; at other places it makes circular reefs called atolls (*see* GREAT BARRIER REEF *and* CORAL ISLANDS).

The accessibility and development of a country depended, and still depend, though to a lesser extent, on its coasts. Safe, sheltered harbours from which easy routes led inland meant ports and trade. Greece, western Italy, southern England, the North Sea coast of Europe, southern Scandinavia, north-eastern U.S.A., and south-eastern Canada all had these advantages. Africa, on the other hand, remained for long the Dark Continent, unknown and mysterious, because its shores are inhospitable and lack safe anchorages.

MANGROVE COAST IN MALAYA

COLOMBIA: A VIEW FROM BOGOTA ACROSS THE PLATEAU TO THE DISTANT SNOW-CAPPED RANGES OF THE CENTRAL CORDILLERA OF THE ANDES. *Dorien Leigh*

COLOMBIA. This is the only South American country with coasts on both the Pacific and Atlantic Oceans (*see* Map, p. 415). It lies next to the Republic of PANAMA (q.v.), which, in fact, rebelled and broke away from Colombia as recently as 1903.

The northern stretch of the ANDES (q.v.) occupies almost half of the country. Three great ranges, the Western, Central, and Eastern Cordilleras, enclose plateaux over 10,000 feet above sea-level, and are separated from each other by the great river valleys of the Cauca and the Magdalena. The River Magdalena, at the mouth of which stands Colombia's main port Barranquilla, and its tributary the River Cauca are used by steamers carrying timber and other products from hundreds of miles up-country to the seaport.

The Western Cordillera rises steeply above a narrow Pacific coastland which is fringed along most of its length by mangrove swamp. The Central Cordillera is mainly a line of snow-covered volcanoes, the chief of which is the extinct Mesa de Herves, its huge crater, 6 miles wide, rising 18,000 feet above sea-level. The Eastern Cordillera, the most important part of the Colombian Andes, has high valleys and plateaux which have a temperate climate well suited to white settlement. Bogota, the capital of Colombia, stands on a very fertile plateau in this region. It is built on a slope, and much of it is terraced. It is planned, as are most South American towns, with parallel streets crossing each other and broken by squares.

Along the Caribbean coast of Colombia there is a low, rich, fertile, coastal plain. Palms of all kinds flourish, and coffee of high quality is grown, as well as bananas, sugar-cane, and rice.

South-east of the Andes, wide, tropical grass-lands, called *llanos*, stretch eastwards to the Orinoco River and the Venezuelan frontier. These pasture great herds of horses and cattle. Farther south, the land falls in forested terraces to the headstreams of the AMAZON (q.v.). Much of this district has not been explored. The forests are thick and rich in tropical vegetation and animal life of all kinds. There are monkeys, pumas, jaguars, and tapirs; the rivers teem with alligators, turtles, and fish; there are boa-constrictors, iguanas, snakes, and reptiles of many kinds, as well as many brilliant birds and innumerable species of insects.

Colombia has considerable mineral wealth, especially gold and emeralds, and its platinum-mines are among the largest in the world. The industrial centre is Medellin, where there are cotton and woollen factories, and cigars, cigarettes, china, and matches are manufactured. The country has over eight million inhabitants.

One of the most interesting of Colombian towns is the old port of Cartagena, founded by the Spaniards in 1533. It was a centre of the Inquisition, and was protected from the sea-raids of buccaneers in the 16th century by massive stone forts and walls.

See also SOUTH AMERICA.
See also Vol. I: COLOMBIA, PEOPLES OF.

COLOMBO. This is the capital of Ceylon, and is about two-thirds of the way south along the west coast of the island. It is the only large city in the whole country, and has a population of about 362,000.

In spite of a poor harbour, Colombo has become an important port because of the many shipping lines which cross there. Most of the government buildings, large shops, big hotels, cinemas, and office buildings are in a district

COLOMBO: PART OF THE FORT, THE ADMINISTRATIVE DISTRICT
Associated Newspapers of Ceylon

near the harbour called the Fort—it was, in fact, originally an old Dutch fort. Outside the Fort is the Pettah, the main native part of the city, and in its narrow streets bicycles, bullock-carts, and rickshaws jostle with trams, cars, and lorries. Cinnamon Gardens is the 'smart' residential area, with broad main streets, many of them lined with gorgeous flowering trees. The city stretches for about 7 miles along the coast, the shops and larger houses petering out on the outskirts into roadside stalls and huts, scattered under coco-nut palms.

Colombo is the main centre of culture in Ceylon, and has a good university. It is hot and sticky, and the weather alters little from month to month.

See also CEYLON.

COLORADO CANYON. This great gorge, over 200 miles long and from 1 to 12 miles wide, has been cut out to a depth varying from 1,000 to 6,000 feet by the Colorado River, in the arid and rocky soil of north-western Arizona, U.S.A. It is one of the best examples in the world of river erosion (*see* DENUDATION, Section 2).

The Grand Canyon is the largest of eighteen canyons cut by the Colorado River. It is a continuation of another canyon known as the Marble Canyon, their combined lengths—nearly 300 miles—making the longest and most spectacular gorge in the world. The Grand Canyon is most awesome and magnificent. The rocks are banded in brilliant and often contrasting colours—the shining white of limestones, the greens, greys, and rusts of sandstones, the brilliant reds of rocks with iron deposits. Wind and water have weathered and eroded, producing scenes of impressive, if at times weird, grandeur: there are towers and turrets, cliffs, ledges, terraces, cracks, gullies, and tributary gorges—and far below, like a silver ribbon when seen from the great height of the sides of the Canyon, the Colorado River, for ever cutting deeper and deeper into the earth. The speed of the river varies from about 3 to 20 miles an hour, though in places it is much faster over low falls and rapids. Though tourists to-day can stay in a luxurious hotel at the edge of the Canyon and gaze at the terraced, coloured slopes a dozen miles across the gorge, or wonder at the strange effects of sunlight and shadow on banks of whirling mist, and even make conducted journeys to the bed of the gorge, yet the Canyon itself is still comparatively unknown.

The Grand Canyon was first discovered in the middle of the 16th century; but little was known about it for another three centuries, when Major Powell with five companions made the first complete journey through it—a journey so dangerous that it ranks as one of the most daring in the story of North America. There have been only a few complete journeys since, two of them

THE GRAND CANYON, COLORADO, FROM THE SOUTH

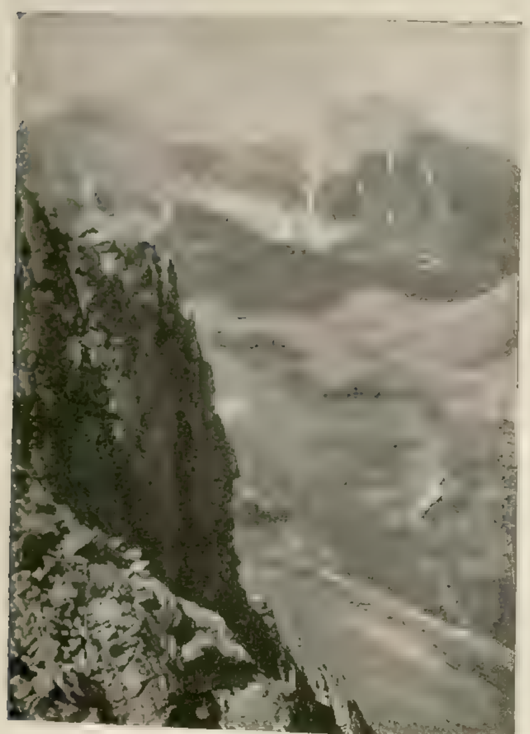
Note the narrow river bed, the stratification of the rocks, and the steep scree slopes below the cliffs

Ewing Galloway, N.Y.

surveys promoted by the Government of the United States to explore the possibility of building a railroad through the Canyon.

See also VALLEYS.

COLORADO DESERT. The Colorado Desert is in the south-west of California in the U.S.A. It is about 200 miles long, and of varying width, at its broadest about 50 miles. It is part of a great expanse of desert land which stretches north and east into Nevada and Arizona, and south into Mexico. To the immediate north, separated from it by mountain ridges, is the Mohave Desert, and then, north again, Death Valley, both of which are in California. The Colorado Desert is on the western side of the Colorado River; on the other side are the deserts of Arizona. The temperature in all these regions is the highest in the United States: even winter days are warm, and in summer the heat is often sizzling. Excellent motor roads with well-equipped filling stations at convenient intervals have to-day deprived them of most of their terrors—the modern traveller in his high-powered car can afford to be amused at MIRAGES



GRAYS PEAK, RISING HIGH ABOVE THE COLORADO DESERT
Royal Geographical Society

(q.v.), forgetful of the very real threat of thirst that hung over the early settler, moving slowly and laboriously across the parched landscape on foot or by wagon.

The landscape of sand and rock is sometimes relieved by fertile stretches where the river has been used for irrigation purposes. In the northern part of the Colorado Desert, shifting sands are a danger and a hindrance; but the southern part, known as Imperial Valley, once waterless, bare, and uninhabited, now maintains a population of over 60,000. Such varied crops are grown as cotton, water-melons, asparagus, winter vegetables, grapes, and dates. This region was threatened with disaster between 1905 and 1907, when the Colorado River got out of control and unmanageable floods looked like sweeping away the valley's prosperity. They were eventually brought under control by the formation of a new inland lake, known as the Salton Sea or the Salton Sink. This great basin, 50 miles long, had once been an arm of the Gulf of California, and then for ages a bed of salt, well below sea-level. The excess waters of the river were diverted into this, and it now forms a weird and almost terrifying sight in a setting of incredible desolation. It is very unlikely that Imperial Valley or any other part of the desert will be threatened again. The building of the great Boulder Dam, on the Colorado between Nevada and Arizona, has tamed the wildness of the river, and brought it under effective control (*see* DAMS, Vol. VIII).

COLOUR. One of the most interesting things discovered by NEWTON (q.v. Vol. V) was that the white light of the sun is made up of light of different colours. He allowed a narrow beam of sunlight to pass through a glass prism on to a screen and found that the screen was coloured with bands of light changing imperceptibly from red to orange, orange to yellow, yellow to green, and so through blue, indigo, and violet. This 'spectrum', as we now call it, was not clearly defined, because a certain amount of overlapping took place: to get the best result lenses must be placed on either side of the prism to focus the rays of light (Fig. 1).

The differently coloured lights contained in sunlight are sorted out so that they appear in separate bands because, in passing through the prism, each colour is bent, or 'refracted', to a different extent (*see* WAVE MOTION, Section 3).

Li is believed to consist of small packets of e   s in the form of electro-magnetic waves.

1. HOW LIGHT IS SPLIT UP INTO THE SPECTRUM WHEN PASSED THROUGH A PRISM

wavelength (or distance from crest to crest) d light is longer than that of yellow, green, lue light; and so red light bends less than ge, as orange bends less than yellow and n.

ust as white light can be split up into coloured ts, so certain coloured lights can be com- ed to form white light. Blue, green, and red its (of particular wavelengths or tints) are three colours which can make white light. r this reason, and because by the right com- ation of some or all of them light of almost y other colour can be produced, these three called the 'primary colours'. When lights ny two primary colours are mixed, the addi- n of the third makes white light. For example, een and blue together make blue-green, and is when mixed with red light makes white ght. Blue-green is therefore said to be 'comple- entary' to red. Similarly, yellow (the mixture f green and red light) is complementary to blue, nd magenta (the mixture of blue and red light) s complementary to green (*see* Colour Plate pposite p. 96). All this applies to *lights* of various colours; when we consider paints or coloured objects, the results are rather different.

We see things because they reflect light. But objects reflect only a certain part of the light which falls on them, the remainder being absorbed. The colour of an object depends on which part of the spectrum it reflects to our eyes. Grass looks green, when seen in white light, because it reflects the green light back to our eyes and absorbs the complementary magenta light. A black object absorbs nearly all the light and a white one reflects nearly all. Seen by coloured light, the colours of objects are not at all the same as in white light. If we were to look at grass in light containing no green at all, it would be unable to reflect any light back, and so would appear black.

When paints are mixed the results are not the same as when coloured lights are mixed. A paint gets its colour by absorbing one complementary colour in the light and reflecting the other. The primary colours of paint—those which can be mixed together to make most other colours—are blue-green, yellow, and red (magenta), because these are the paints which absorb only the primary colours of light and reflect back the rest. Blue and yellow, for instance, make green because they both reflect green light but absorb the other colours of the spectrum. If two paints of exactly complementary colours were mixed thoroughly, they would absorb all the light between them and so appear black. In fact no paints are ever pure, and so when mixed they do not absorb all the light, and the result is a neutral grey. Artificial light has a different spectrum from that of daylight; and so objects do not look the same colour at night as in day-time. No woman would try to match the colours of materials under artificial light: she knows by experience that they would look different in daylight. Similarly, film-actors and actresses have to paint their faces yellow and purple before going on the set, in order to allow for the effect of the powerful artificial lights used.

When waves of any kind meet an obstacle small compared with themselves they can sweep on almost without disturbance; but if they meet a bigger obstacle they may be absorbed or reflected back. The wave-lengths of the various coloured lights are all so small that even tiny particles of dust can easily deflect them. Blue light, having almost the shortest wave-length in the spectrum (0·00004 cm.), is very easily deflected. The reason that the sky appears blue on a sunny day is that while the coloured light of longer wave-length is able to pass on more or less undisturbed, and the shorter violet and indigo waves are largely absorbed, the blue part of the sun's rays is reflected by the particles present in the earth's atmosphere, and it is these blue rays which we see. In the evening, when the sun is low down upon the horizon, its light has to travel much farther through the atmosphere, with the result that the blue and green rays are almost all absorbed, and it is the red (with a wave-length of 0·00007 m.) and the yellow which are reflected to our eyes. If we sit with our back to the light and watch the smoke rise from a cigarette, it appears blue because its particles reflect back only the blue rays. Smoke

breathed out by a smoker contains bigger particles, because of the moisture in his breath. The bigger particles reflect light of rather longer wave-length than blue—and so the smoke looks grey or even brown.

Newton's discovery of the spectrum of sunlight had results of the greatest importance to science, because it led directly to the development of the SPECTROSCOPE (q.v. Vol. VIII) or spectrometer. Light of any kind is found to possess a characteristic spectrum of bright-coloured bands and dark lines, which can be very exactly analysed with the help of these instruments. In particular, if any element is raised to a temperature at which it gives off light, its presence is easily detected in the spectrum, even though it is present only in minute quantity and mixed with various other substances. Spectroscopy, then, is very useful in chemical analysis; but its most striking use perhaps is in astronomy. By its aid the presence or absence of various elements can be discovered in the stars and other heavenly bodies. Moreover, from our knowledge of the Doppler Effect (*see* WAVE MOTION, Section 5), it is even possible to measure the movement of these bodies relative to the Earth. Finally, spectroscopy has been of great value in studying the structure of the ATOM and in the development of the QUANTUM THEORY (qq.v.).

See also LIGHT; RAINBOW.
See also Vol. VIII: SPECTROSCOPE.

COMETS. Occasionally, luminous bodie ith a blunt 'head' and a misty 'tail' appear the sky, and follow tracks which show that, li the Earth and planets, they are moving ler the influence of the Sun's gravitational pul ut whereas the orbits of the planets (althoug ey are ellipses) are almost circular, those f ed by comets are enormously elongated (*see* I). The result of this is that after increasi a maximum brightness within at most w months, a comet then gradually fades a s- appears into space, to return, if at all, a an interval that may be anything from a fe rs to several thousands.

Comets vary greatly in size. A large o ay have a head 865,000 miles in diameter (t ze of the Sun) and a tail millions of mil g. In spite of this, however, the amount of ter in them is almost inconceivably small. vas calculated of a comet which came wi a million and a half miles of the Earth in 17 at if its mass (or, roughly, weight) had been al to the Earth's, our year would have en permanently lengthened by nearly 3 h as a result of its gravitational pull. Since t ar was not lengthened by even 1 second, th ss of the comet must certainly have been le an $\frac{1}{10,000}$ that of the Earth's. Stars can be ly seen through the material of the tail nd often they can be seen through the he A comet's light is partly due to reflection m the Sun; but its own c- trum shows carbon nd nitrogen compounds, ith some metals in the ad (*see* COLOUR). Perhap the luminosity of the tail an electrical effect—like that in the gas-filled tubes we see in some shops or outside cinemas. The tail always points away from the Sun, as shown in Fig. 1, the reason being possibly that the particles of matter in it are so small that the outward pressure of the Sun's radiation on them is greater than the pull of its gravitation (it is known that light exerts a small pressure when it falls on any body —*see* QUANTUM THEORY).

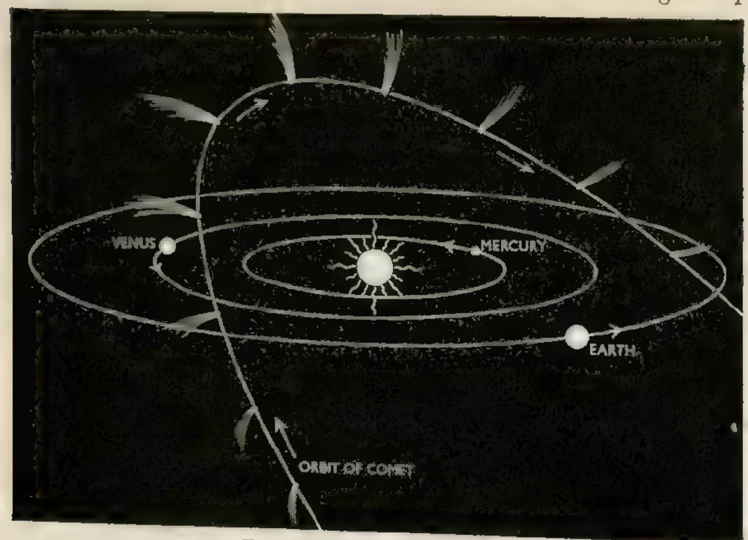


FIG. 1. THE PATH OF A COMET
The orbit of a comet may be at any angle to the plane of the solar system. The tail grows larger as it nears the sun and diminishes as it gets farther away. It always points away from the sun.

The origin of comets is still uncertain; but two clues are strongly suggestive. A comet observed in 1826 was found to have split into two parts on its return in 1846. When it was next seen, in 1852, the two parts were much farther apart; and in 1872 there was no comet —but in its place, and moving in its orbit, a shower of METEORS (q.v.) was seen. Secondly, the orbits which have been worked out for several comets are found to be identical with the orbits of well-known groups of meteors. It is thought, then, that the head of a comet consists of a cluster of meteors which is partly broken up and spread out into a tail by radiation and other forces when its orbit brings it near the Sun.

In times past, comets were thought to foretell catastrophe, and their appearances have often caused the greatest alarm. For example, the comet in 1066, which is shown on the Bayeux Tapestry, frightened William the Conqueror's men. But these very records of dismay have proved useful in fixing, by calculating back, important dates in early history. Sometimes the return of a comet can be predicted successfully, but sometimes not. About 20 per cent. of the comets have been visible to the naked eye (as the ones recorded before the year 1600 must all have been), and nowadays we know that they average about six per year. Prof. Halley, using Newton's methods, was the first to be successful in predicting the return of a comet in 1759; but he did not live to see it. This comet, which was seen again in 1910, is known to be the one depicted on the Bayeux Tapestry and also to have been recorded by Chinese astronomers in 87 B.C.

Occasionally comets of quite remarkable splendour are seen. One which appeared in 1861 had a tail that at one time extended almost half the distance across the sky from horizon to horizon. The Earth was thought to have passed through its tail (without any effects being noticed) on 30 June of that year. Other noteworthy comets of the 19th century were seen in 1811, 1843, 1858, 1874, and 1882. In the present century Halley's comet returned in 1910, and Morehouse's, shown in the photograph, was seen in 1908. In December 1947 a comet was seen, mainly from places in the Southern Hemisphere, which was brighter than any seen since 1910, but it only lasted for a few days.

See also PLANETS, Section 1; METEORS.

COMPOUNDS, CHEMICAL, *see* CHEMISTRY.

MOREHOUSE'S COMET, 1908
The stars look like streaks because of the length of the exposure of the photograph
Royal Observatory, Greenwich

CONGLOMERATE is a GRAVEL (q.v.) which has been cemented by particles of sand into solid rock. Because it resembles a pudding in which stones take the place of plums, it is often called 'pudding-stone'.

When the stones which have been cemented together are sharply angular, the rock is called a 'breccia' (pronounced 'bretchia') instead. Breccias are often found along 'faults', where the edges of beds of rock have splintered against one another.

See also ROCKS, Section 3 (*e*); ROCK FORMATION.

CONGO RIVER. This great river of central equatorial Africa is over 3,000 miles long. It rises in the highlands of Northern Rhodesia, south of Lake Tanganyika, takes a great bend through Lakes Bangweulu and Mweru, and flows northwards, under the name of Luapula, into the Belgian Congo (*see* Map, p. 5). Then it joins the Lualaba, under which name it flows through varied country of hills, swamps, savannah, and forest, until it reaches the Stanley Falls and Stanleyville. It then bends west and south, flowing through dense evergreen tropical forest in which the rivers are often the only thoroughfares. As the river grows wider, joined by innumerable tributaries, it flows round many

islands, some of them 30 to 70 miles long, and all of them covered with dense forest right down to the water's edge. At Irebu it is joined by the Ubangi, another enormous river, which flows west and then south, forming for hundreds of miles the boundary between French Equatorial Africa and the Belgian Congo. Farther down, the second great tributary, the Kasai, joins the Congo from the east. This river rises near the head-waters of the Zambezi, and gathers in, as it flows north-west, the waters of a vast number of streams and rivers. Near Leopoldville, the capital of the Belgian Congo, the Congo enters a hilly district and flows through gorges and over waterfalls until it reaches Matadi. For the last 100 miles of its 3,000 miles' course, it widens, reaching the Atlantic in an estuary 7 miles wide.

Although some 1,000 miles shorter than the River Nile (q.v.), the Congo and all its tributaries carry more water to the ocean than all the other rivers in Africa together. This is because the river drains an enormous circular plateau of highland averaging over 1,000 feet above sea-level. In the two seasons of heavy rainfall so much water comes down that the river floods the surrounding forest for miles. The Congo is navigable for ocean-going steamers as far as Matadi, a hundred miles inland. The ships carry manufactured goods upstream, returning laden with such goods as palm-nuts, palm-oil, rubber, and cacao beans. Then for over [illegible]50 miles a railway by-passes a series of gorges, rapids, and waterfalls which make the river impassable. Above Leopoldville the Congo is again navigable for steamers for another [illegible]00 miles, as far as the Stanley Falls, which also are skirted by a railway. Above the Falls long stretches of the river again form a valuable waterway. Altogether the Congo provides 2,100 miles of navigable waterway, a very important fact in tropical forest country.

The course of this great river has only been known to white men for about seventy years. The Portuguese navigator Diago Cao had discovered the estuary as early as 1484; but in those early days, few explorers of Africa ventured far inland. When Livingstone first reached the Lualaba in 1871, he thought he had

THE RIVER KASAI, ONE OF THE GREAT TRIBUTARIES OF THE CONGO
Belgian Colonial Office

THE NORTHERN HEAVENS

In the centre is the Pole Star nearly at the exact point of the north celestial pole, around which the other constellations appear to revolve. It is easy to find the Pole Star by first looking for the Great Bear (sometimes called The Plough): a line joining the two end stars, called 'the Pointers', will lead towards the pole.

The Pole Star always appears to be in the same position and at the same altitude. The Great Bear may appear sideways or upside-down, and the map must be turned accordingly.

reached the Nile; but Henry STANLEY (qq.v. Vol. V), after his great journey downstream in 1875–7, proved that Livingstone's Lualaba went right across Africa to meet the Atlantic Ocean.

See also BELGIAN CONGO; RIVERS.

CONSTANTINOPLE, *see* ISTANBUL.

CONSTELLATIONS are groups of stars to which names have been given, often because they are imagined to resemble some fabulous personage or object. The practice of identifying certain stars in this way dates from long before written history; but most of the names used to-day are taken from the mythology of ancient Greece or from Latin equivalents. The constellations still help astronomers to group the stars, though they are supplemented to a great extent by references to recognized star 'catalogues'. Many of the best-known constellations lie in the Zodiac and are listed in the nursery jingle:

> The Ram, the Bull, the Heavenly Twins;
> And next the Crab, the Lion Shines,
> The Virgin and the Scales,
> Scorpion, Archer and Sea-goat,
> The Man who pours the water out,
> And Fish with glittering tails.

THE CENTRAL (OR EQUATORIAL) HEAVENS, NOVEMBER TO JUNE

To use the maps in the northern hemisphere, first look for the month of observation; constellations appearing below the month named will be visible towards the south in the evenings. Stars which are near the top of the map may appear overhead; those near the bottom of the map may be out of sight, below the horizon. The exact position of any constellation varies according to the time of the night and the date, and since the constellations rise and set at an angle, it may be necessary to hold the map in a slanting position.

The Zodiac is an imaginary belt of a width of 9 degrees encircling the heavens on either side of the ecliptic (the annual path of the Sun through the fixed stars as seen from the Earth—*see* ASTRONOMY, MODERN, Fig. 1). The original purpose of the signs of the Zodiac was probably connected with the handing down of primitive myths; but at a very early date they came to be used in the practice of ASTROLOGY (q.v. Vol. I). The width of the Zodiac included the paths of all the five planets whose existence was known at that time: Mercury, Venus, Mars, Jupiter, and Saturn. The twelve constellations of the Zodiac were each allotted a space in the heavens of 30° (1/12 of 360°), called a 'Sign', which afforded a convenient method of defining the position of the Sun and planets at any particular time. The symbols denoting the Signs of the Zodiac are: Aries (Ram) ♈; Taurus (Bull) ♉; Gemini (Twins) ♊; Cancer (Crab) ♋; Leo (Lion) ♌; Virgo (Virgin) ♍; Libra (Scales) ♎; Scorpio (Scorpion) ♏; Sagittarius (Archer) ♐; Capricornus (Goat) ♑; Aquarius (Water-carrier) ♒; Pisces (Fishes) ♓.

Owing to the slow circular swing of the Earth's axis, called 'precession' (*see* ASTRONOMY, MODERN, Section 4), the constellations of the Zodiac no longer correspond to the positions of their signs in the sky. Thus Pisces is now to be found in the Sign of Aries. Their original positions are only repeated once in every 26,000 years—the time taken for the Earth's axis to make one complete swing. With the decay of belief in astrology, the Zodiac has ceased to have

THE CENTRAL (OR EQUATORIAL) HEAVENS, MAY TO DECEMBER

The celestial equator runs along the middle of the two maps. At an angle is the curved line of the ecliptic, which marks the apparent path of the sun, moon, and planets. A bright star near this line and not marked on the maps may be recognized as one of the planets.

The constellation names are given in Latin, but the mythical figures which appear on old charts have been omitted, so as to make the maps clearer. The top edges of these maps overlap the map of the northern heavens on page 107; the bottom edges overlap the map of the southern heavens on page 110.

any practical importance, though the constellations in it still provide a convenient means of reference, as do those in other parts of the heavens.

Outside the Zodiac, the constellations are divided into the northern and southern groups. Some of the latter are visible only in the Southern Hemisphere and, since most astronomers have lived in the Northern Hemisphere, they have received comparatively little study and their naming is relatively modern—perhaps the only name familiar to us being the Southern Cross. Many of the northern constellations, however, bear familiar names. The Great and Little Bear (Ursa Major and Minor) are well known. The Pole Star forms the end of the Little Bear's tail, and is most easily found by reference to the Pointers, two of the seven bright stars in the constellation of the Great Bear (often known also as The Plough). Prominent in the winter sky is the great constellation of Orion the hunter, three stars forming his belt and three smaller ones his dagger. The centre one of these last is, actually, not a star but the Great Nebula of Orion (*see* NEBULAE, Fig. 1). The seven beautiful stars of the Pleiades are easily found and, half-way between them and Orion, is a great red star called Aldebaran. On Orion's shoulder the giant orange star Betelgeuse shines. Orion's belt points downwards to Sirius, the Dog-star, the brightest in the whole sky. In modern astronomy the individual stars are identified by adding a letter or number to the name of the group. The Greek

THE SOUTHERN HEAVENS

The constellations near the centre of this map can be seen only from places in the southern hemisphere. There is no bright star near the south celestial pole, but the arms of the Southern Cross serve as a guide to the direction of the pole. The southern parts of the Milky Way appear more brilliant than the northern. There also appear two clouds of stars, like faint patches of light in the sky, known as the Lesser and Greater Magellanic Clouds, named after Magellan, who first sailed round the world. *Maps by Peter Hood*

alphabet is first used, the earlier letters being generally given to the brighter stars. When the last of the Greek letters has been reached, a start is made with the Roman ones, and after those with numerals. Thus α Centauri means the brightest star in the Centaur constellation, 61 Cygni a particular star in the constellation of the Swan.

CONTINENTAL DRIFT. The first suggestion that there has been a movement or drift of the continents across the globe is usually credited to Alfred Wegener in this century; but the idea had, in fact, been put forward many years before his birth.

In 1858 a book was published suggesting that the Americas, Europe, and Africa must all have been joined together at the time when the coal-bearing rocks were being formed, because the coasts of South America and Africa matched each other so exactly. Then in 1908 F. B. Taylor suggested in America that the Dolphin Ridge, a submarine mountain range in the Atlantic, might once have linked South America with Africa. He pointed out, too, that the shores of Labrador and of south-western Greenland run almost parallel for over 400 miles, and that the structure of the two coasts is very similar, so that they would fit together like pieces of a jigsaw puzzle. North-west of Greenland, and separated

from it by a narrow channel, lies Ellesmere Island. Taylor pointed out that if Greenland were moved 330 miles to the south-west, its north-west coast would fit into the opposite coast of Ellesmere Island, and that the rocks on either side of Smith Sound would exactly correspond. Similarly the south-west coast of Greenland would fit into the north-east coast of Baffin Island to form one block. Then if this block—Greenland, Ellesmere Island, Baffin Island—were moved a further 130 miles to the south-west, the south-west coast of Baffin Island would fit into the north-east coast of Hudson's Bay, and moreover, the south-west coast of Greenland would join with the coast of Labrador. So Greenland would become part of the American Continent. It is hard to believe that this fitting together of the coasts and matching of the rocks is mere coincidence.

Without knowing of Taylor's work, Wegener had been developing similar ideas in Germany, and in 1910 he published a book putting forward the theory of the Drift of the Continents in much greater detail and with much more evidence. He pointed out that there are coasts which fit in shape and correspond in geological structure, not only in South America and Africa, and Greenland and Labrador, but also in Madagascar and south-east Africa, in Arabia and north-east Africa, and also elsewhere. He explained the triangular shape of the southern continents—South America, Africa, India, and Australia (with Tasmania)—by supposing that all had once formed part of a huge land mass at

GREENLAND AND THE NORTH-EAST COAST OF NORTH AMERICA

the Antarctic, but that this had split along cracks radiating from the South Pole. Later, the parts had broken off from the Antarctic Continent, and had drifted towards the Equator, thus moving

THE POSITION OF THE CONTINENTS ROUND THE SOUTH POLE IN THE CARBONIFEROUS AGE, ACCORDING TO WEGENER
From S. J. Shand, 'Earth Lore'. (T. Murby.)

farther from one another. Rift valleys where movement is still taking place show us that this idea of a long crack in a land mass can in fact happen.

Taylor thought that Greenland had split from North America and drifted eastward: Wegener claimed that this eastward drift is still continuing, though slowly—not more than 30 yards a year. To try to prove this he led an expedition to Greenland in 1930; but the trip was dogged by misfortune and Wegener lost his life. His theory, however, was the most important contribution to a line of thought which not only fits in with the known plastic nature of the earth's subcrust, but which, with adjustments and development, may eventually enable us to explain the shape of the continents, the climates of past ages, the distribution and migration of animals both living and fossil, the distribution of living and fossil plants, and even the formation of the great curved mountain chains of the earth's surface.

See also EARTH; EARTH, HISTORY OF; MOUNTAIN BUILDING.

CONTINENTAL SHELF, *see* OCEANS; EUROPE.

CONVECTION, *see* HEAT, Section 4.

COPENHAGEN. The name Copenhagen means the 'Merchant's Harbour', and Copenhagen has always been a great trading port. It

COPENHAGEN: THE OLD AND NEW TOWN HALLS FLANK THE RAADHUSPLADSEN

Danish Travel Association

is the capital of Denmark and has a population of about 980,000.

Copenhagen lies partly on the island of Zealand and partly on the much smaller island of Amager. The water between the two islands—a branch of the Sound that divides Sweden from Denmark—forms the main harbour. To the west of the town there is a group of small, fresh-water lakes. To the north lies the Dyrhave (deer park), a forest of beautiful beech-trees, many of which were cut down for fuel during the First World War. The coast northwards, between Copenhagen and Elsinore (Helsingor), is lined by small seaside towns and villages from which many travel to work in the city.

Central Copenhagen is a mixture of wide, dignified squares and boulevards lined with trees and pavement cafés, and of narrow twisting streets, cobbled, and noisy with trams. Little lanes of water, along which it is possible to go by water-motor-bus, penetrate into the town from the Sound. The old Christiansborg Palace, twice burned down and twice rebuilt, holds the Parliament, the Foreign Office, and the Courts of Justice. The King lives in one of the four buildings of the Palace of Amalienborg, that face each other from the four corners of a square: members of the Royal Family live in the other three. The old Castle of Rosenborg, which stands in its own park, is now an historical museum. The Royal Porcelain Factory, which makes one of Denmark's best-known products, is in Copenhagen.

In the big squares, on market days, fish, fruit, flowers, vegetables, and many other things are sold. Most of the fruit, vegetables, and flowers come from the nearby island of Amager. In the middle of the city is Tivoli Park which, with its theatres, concert halls, restaurants, fairs, and boating lake, is the main centre of amusement for Copenhagen.

One of the most attractive features of Copenhagen is its harbour life. A fascinating walk can be taken along the edge of the Sound, past the statue of the Little Mermaid on her rock, a memorial to the best-loved of all Danes, Hans Christian ANDERSEN (q.v. Vol. V). Here can be seen the never-ending traffic of the harbour—the grimy cargo ships and the white-sailed yachts, the grey men-of-war and the pleasure cruising liners. The flags of all maritime nations pass through Copenhagen Harbour, part of which is a Free Port, where goods can be re-shipped without customs duty. It is a centre for the whole Baltic trade. From across the water comes the sound of hammering from the shipyards—'Such impress of shipwrights' as Hamlet's friend Marcellus heard, long since, at nearby Elsinore.

See also DENMARK.

COPPER ORE, *see* METAL ORES; *see also* Vol. VII: COPPER MINING.

CORAL ISLANDS. These words conjure up fair visions of blue skies and hot sun, cool breezes from deep-blue seas, green waving coco-nut palms round sheltered lagoons, firm sandy beaches, and friendly, handsome people. Some coral islands are just like that; others are but barren rocks and the nesting places of sea-birds; while others, again, are peopled by natives who are by no means friendly.

The term 'coral islands' is often used to include islands which are merely ringed by coral reefs—such as Tahiti, which is volcanic, or the Seychelles, which are of granite. Here it means

islands almost entirely made up of Coral (q.v. Vol. III). This rock is composed of the skeletons of myriads of coral animals. These creatures, which are akin to sea-anemones, can live only in warm water of a temperature not less than 68° F.; and so all coral islands lie in the Indian and Pacific Oceans between the latitudes of 30° N. and 30° S. of the Equator. There are very few in the Atlantic. Furthermore, the water must be clear and unpolluted by the mud which rivers bring down to the sea: and so, except for those in the deep Macassar Strait and the East Java Sea, coral islands lie well away from the continents. The islands usually occur in groups. In the Indian Ocean they form the Laccadive, Maldive, and Chagos Islands. In the Pacific Ocean the principal groups are the Marshall, Gilbert, Ellice, Phoenix, Tokelau, and North Cook Islands, the islands of the Macassar Strait and of the East Java Sea, and part of the Tonga, Samoa, South Cook, Society, Tuamotu, and Fiji Islands (*see* Maps, pp. 322 and 323).

Most coral islands are atolls. The word 'atoll', which comes from the Maldive Islands, means a roughly circular reef enclosing a lagoon. Parts of the reef (very rarely the whole circle) are high enough to form islands, so that an atoll usually looks like a chain of islands. Atolls vary greatly in size. Suvadiva, at the southern end of the Maldive Islands, is the largest in the world. It measures 42 miles from north to south, and 32 miles from east to west, and over a hundred islands lie on its encircling reef.

Several explanations have been given for the formation of atolls. Their ring shape is probably due to the fact that those coral animals on the outside of a large mass get a better food-supply from the surrounding ocean than those in the middle. So there is a tendency for the outside of the coral mass to grow faster than the inside, and to reach the surface sooner. It is more difficult to explain how atolls can grow up from deep water, when the coral animals themselves cannot live at a greater depth than about 100 feet. The great naturalist Charles Darwin (q.v. Vol. V) suggested that in such cases growth must have started when the sea was shallow and that later, in a great subsidence of the ocean-bed (*see* Mountain Building), the growth of coral upwards had kept pace with the movement of the sea-floor downwards. It is supposed that the coral reef can grow at the rate of about an inch in height a year. Other suggestions are that

A CORAL REEF AT LOW TIDE IN THE NICOBAR ISLANDS, INDIAN OCEAN

atolls are built on tops of submarine mountains or shoals, or that the ocean-bed is gradually raised up to the necessary height by the accumulation of shells and skeletons of sea creatures, such as have formed the sedimentary Rocks (q.v. Section 3 *e*). Probably each explanation is the right one for certain atolls.

Once a coral reef has been built up almost to the surface, the action of the waves can pile it higher by breaking off great pieces of coral and piling them on the top of each other. Sun and wind, and the work of marine borers, help the water to split and grind the coral to sand. This blows and drifts higher and higher. Some atolls have risen so much above the sea that there is no longer an island-encircled lagoon, but instead an island with a hollow in the middle. Seeds of plants and trees are carried by water, wind, or bird and take root. Whole trunks of trees from other lands may drift ashore, carrying insect life and even small animals. Sea-birds, and perhaps some land-birds, will already have taken possession. Eventually, perhaps, man has come along and found a home to his liking. Such is the story of a typical atoll.

Apart from chance castaways, there are no animals on coral islands except those which can move by water, such as turtles and crabs. On the larger islets there is usually near the sea a belt of low bushes, some of which are thorny. On the main part of the islets there are coco-nut groves, while on the lagoon side of the coco-nuts where the soil is more sandy there grow bananas, bread-fruit, pomegranates, tomatoes, gourds, and sometimes maize.

See also Indian Ocean Islands; Pacific Islands; Great Barrier Reef.

CORNELIAN (CARNELIAN), *see* Agate.

CORONA: (Solar), *see* Sun; (Atmospheric), *see* Rainbow.

CORSICA. Though it is now under French rule, Corsica is more truly Italian by reason of its inhabitants, its history, and its geographical position. It lies due south of the Gulf of Genoa and immediately north of the Italian island of Sardinia, from which it is separated by the narrow Strait of Bonifacio (*see* Map, p. 160). The Italian mainland lies little more than 50 miles to the east. Corsica is a mountainous fragment of an old land mass, now submerged, with high ridges separating secluded valleys. It is 114 miles from north to south, and 52 miles from east to west. In the north Mt. Cinto rises to 9,000 feet above sea-level, while on the west the mountains slope down to a rocky coast broken by deep bays. The marshy alluvial plain of Aleria on the east coast is very fertile, but malaria infested.

Only about a third of the island is cultivated, much of the rest being covered with *maquis*, that is, low bushes and undergrowth. The mingled scents of myrtle, blackthorn, thyme, rosemary, and broom have earned Corsica the name of 'The Scented Isle'.

Most of its 300,000 people live between 600 feet and 3,000 feet, where the climate is healthier. The sweet chestnut and the Corsican pine grow there, the chestnuts being ground into flour and the wood used for building. Sheep and goats are kept, and the making of goats' cheese and the tanning of leather are important occupations. In the mountainous interior wild sheep, known as 'mouflons', are found. Farms are small, and the land is much subdivided into scattered plots. There is some charcoal-burning, whilst walnuts, olive-oil, almonds, and cork are produced for export. One interesting product of the uplands is *bruyère*, the root of a heath plant, which is used for making 'briar' pipes. On the lower slopes of the mountains vines are grown and silkworms reared.

The history of Corsica has been one of war and vendetta. The original inhabitants were probably Ligurians from the north coast of Italy. Later, the island was colonized by Etruscans, Carthaginians, and Romans. The Romans used the island as a place of exile for political offenders. Every nation that invaded the Mediterranean tried to take Corsica because its central position made it an ideal location for piracy on the main shipping routes. Later, the Vandals came, and were followed by the Goths and Lombards, then by Arabs, Franks, and Tuscan Counts. Both Italy and France fought over it, and a German adventurer tried to rule the island as Theodore I in the 16th century. Finally, Corsica passed to France in 1769, the year that Napoleon was born there, and—except for two brief periods when it came under British rule—it has remained in French possession ever since.

During each invasion the Corsicans retired to the mountain interior and engaged in endless guerrilla warfare. The people are, as a result, backward and impoverished. Even to-day, blood feud is practised, for the Corsicans are not only ardent patriots but also zealous upholders of family rights. Rather naturally, they have a strong dislike of foreigners. It is difficult to get them to develop the resources of the island, as they are very independent, and dislike hard work. Every year workers come from Tuscany to till the fields—because the Corsican prefers to argue politics!

The towns of the uplands are small and medieval in character. Corte and Venaco are the eastern centres for the richer highland areas. The ports of Bastia and Bonifacio, on the east and south coast, originated as fortresses and have little contact with the interior: both trade chiefly with Italy. A railway runs from Bastia to Ajaccio, the most important town and port, and has to climb 4,000 feet to cross the island. Ajaccio lies at the head of a beautiful mountain-girt bay, and trades mainly with France. It has a population of 40,000.

The French Government has tried to increase the tourist traffic to the country, and sea-planes

MONT SIGNORE ON THE WEST COAST OF CORSICA

The mountain rises steeply from the Gulf of Porto. The lower slopes are covered with low bushes or *maquis*

Paul Popper

link Ajaccio with the Riviera. There have been attempts, too, to develop mining of antimony, anthracite, and copper.

COSMIC RAYS. These are rays of enormous energy bombarding the earth from outer space. The discovery of their existence was a gradual process starting at the beginning of the 20th century. Air had always been regarded as an excellent insulator for electricity; yet in 1900 it was noticed that, however carefully an electrically charged body was isolated from the earth, it still gradually lost its charge. In 1903 Rutherford (q.v. Vol. V) and Cooke, after careful experiments, declared that the atmosphere behaved like a conductor of electricity—though a very poor one; and that this was because it was being ionized. Ionization occurs when an Atom (q.v.) is bombarded by some electrically charged particle which either knocks out of it or forces into it one or more electrons, thus upsetting its electric balance. Atoms in this state are no longer electrically neutral, but are either positive or negative according to whether they have lost or gained electrons, and they are called ions. Some of these ions are attracted to the charged body and slowly neutralize its charge, so that it gradually becomes discharged.

Rutherford and Cooke decided that the ionization of the atmosphere was probably due to electrically charged particles sent out by radio-active materials in the earth—although this particular radiation was vastly more powerful than any previously known. An attempt to decide this was made in 1909, when a series of balloon ascents was made to measure the intensity of ionization of the atmosphere at different heights. It was expected that this would decrease as the distance from the earth increased—but on the contrary, the intensity was found to be greater for greater heights. It was later established that the intensity of ionization at a height of 5 miles was seven times as great as at the earth's surface. Therefore it was unlikely to be caused by radio-active material in the earth. In 1921 Millikan was able to state definitely that the ionization was due to rays which came from outer space (i.e. outside the earth's atmosphere), and for this reason they were given their name.

There remains still much to be discovered about cosmic rays. They are almost certainly streams of electrically charged particles—just what sort of particles is not yet known, though some scientists believe them to be protons (*see* Atom). As to their origin, it was thought that they might be emitted by the sun; but it is now known that they come to us from somewhere outside the solar system. Their particular interest and scientific value lie in the immense energy they contain—more than sixty times as much as that given out by the splitting of uranium in an atomic bomb. Already scientists have been able to put this to such good use as to identify two new kinds of particles present in the atom ('positrons' and 'mesons') whose existence had been calculated but never proved real. Now, by the aid of cosmic rays their tracks have actually been photographed. It may well be that in the atomic age now beginning cosmic rays may come to play a part of the greatest importance.

See also Radiation.

COSTA RICA, *see* Central America.

CRETE. This is the fifth largest island of the Mediterranean (*see* Map, p. 160). It is 16[illegible] miles long from east to west and its width varies between 7 and 35 miles. High mountains rise very steeply in east–west chains along the middle of the island. The highest peak, Mount Ida or Psiloriti, rises to over 8,000 feet.

Crete owed her early importance to her position between Greece and Turkey, and to the fact that she was the nearest part of Europe to Egypt. The Greeks conquered her, and Cretan pirates helped in the wars between the Greeks and the Romans. Later, the island was held successively by Arabs, Byzantines, Crusaders, and Venetians. Finally the Turks captured Crete and ruled it for 220 years till 1897. It is now part of Greece.

Most of these conquerors have left traces of their occupation. In the old capital, Candia (also known as Erakleion and Megalokastron), there are narrow streets with high walls and heavily shuttered windows, relics of Turkish rule, and, in the main square, a palace and fountain date from Venetian times.

The coast is on the whole inhospitable. Inland, however, there are fertile fields, orchards, olive-groves, terraced vineyards, and, on the hill slopes, a wealth of shrubs and flowering plants. The mountains enclose small plains at heights from about 3,000 to 6,000 feet above sea-level. These plains are the basins of lakes

A MOUNTAIN VILLAGE IN SOUTHERN CRETE
E.N.A.

hat have dried up or drained away—for the island is almost all limestone. At the side of the plain of Nida there is a huge cave which legend says is the place where Zeus was born. The plain of Messara was the centre of MINOAN CIVILIZATION (q.v. Vol. I) which flourished from about 3000 to 1400 B.C., and at Knossos archaeologists have revealed the ground-plan of the great palace of King Minos—the builder of the famous maze where the Minotaur was kept.

Khania (Canea), the modern capital, is, like Candia, the old capital, on the north coast. It has a fine harbour and well-planned streets. There are no railways in Crete and few good roads. Bridle-paths are the usual highways, and Cretan mules are known throughout southern Europe. Hotels are rare, and the traveller must still trust for food and shelter to the hospitality of monasteries.

CROATIA, *see* YUGOSLAVIA.

CRYSTAL, *see* MINERALS; ROCK-CRYSTAL.

CUBA, *see* WEST INDIES.

CURRENTS, *see* OCEANS, Section 6.

CYCLONES, *see* WEATHER; HURRICANES.

CYPRUS, which has been under British administration since 1878, and under the British Crown since 1914, is the third largest island in the Mediterranean, after Sicily and Sardinia. One hundred and forty miles long, and 60 miles wide at its widest point, it lies about 40 miles south of Asia Minor, 60 miles west of Syria, and 260 miles north of Egypt (*see* Map, p. 160). Its population is about 492,000.

The island is well wooded, and mountainous. Along the north coast the Kyrenia Range runs east and west, with an average height of 3,000 feet. The narrow coastal plain and the steep valleys, filled in spring with wild flowers, are very lovely. The southern range—the Olympic Mountains—rises to a height of 6,400 feet in the peak of Mount Troödos, on the slopes of which

CYPRUS: THE KYRENIA RANGE
In the foreground is the tower of a medieval castle. *Commissioner for Cyprus*

is the summer station of the Cyprus government. There are fine cypress forests in the mountains, but large areas have been cut, leaving only scrub. In these areas the heavy winter rainfall has caused extensive damage and loss of soil by erosion (*see* SOIL EROSION).

Between the two mountain ranges lies the Messaria Plain, treeless, dry, and parched in summer. In the centre of this is the capital Nicosia, with a population of 39,000. The other cities of Cyprus are on the coasts, situated where indentations give safe anchorages. The most important are Famagusta, Limasol, and Laruaba. Laruaba (12,000) is of ancient origin, and was known to the Romans as 'Citium'. To-day it is the island's chief sea-port.

The climate of Cyprus is Mediterranean in character, with a hot, dry summer, the day temperature rising above 100° F. in the plains. Rainfall, about 23 inches, comes in the winter months, between November and April. At this time of year the rivers tumble down the mountain valleys as torrents, causing flooding in the plain. In the mountains there is snow in winter, with temperatures corresponding to those of Britain. The mountain climate in summer is dry, bracing, and altogether delightful.

Cyprus produces wheat, barley, and locust beans (which are manufactured into cattle-cake). Among fruits, oranges, lemons, plums, apricots, grapes, cherries, and apples grow in the island. Large quantities of wine are exported, chiefly to Greece and Egypt. Olives are grown for oil which is consumed in the island. Other products are cotton, flax, silk, and tobacco.

Agricultural methods are still primitive, and an ancient, but effective, method of irrigation by wells is used. The wells are connected by underground channels, from which water is drawn up to storage tanks. Large herds of sheep and goats graze on the scanty pasture, and breeding of mules and donkeys is carried on. The Cyprus mules are noted as excellent pack-animals.

The mineral products of Cyprus include copper, magnesite, gypsum, and asbestos. In ancient times, the copper of Cyprus was so famous that it gave the island its name. The Phoenicians and the Romans worked it—and traces of their ancient mines are still to be seen; but nowadays only low-grade ore is produced. Asbestos comes from the hills near Troödos, and about 4,000 tons of fine quality are exported annually. Sponge-fishing, a profitable industry, is carried on round the coasts.

CZECHOSLOVAKIA. This is not a very large country—it is only a very little bigger than England and Wales—but its position in central Europe and its wealth make it very important (see Map, p. 160). It is a long, rectangular country of mountains, plateaux, basins, and plains; of forests and agricultural land; of mountain villages with hand-weavers, toy-makers, and embroiderers; of watering-places and medieval towns, and very modern mining and industrial areas. PRAGUE (q.v.), the capital, on the River Vltava, is typical of the curious contrasts to be found everywhere: on one side of the river is the castle, the cathedral, and beautiful 16th and 17th century houses—and on the other side are the factories and flats of the modern city.

The western part of Czechoslovakia is called Bohemia; it is a high block of mountainous country enclosing several basins and one large plain, the Labe Plain, or plain of the Upper Elbe. Most of the mountains and much of the rest of the country are forested; but there are many small cleared areas, with little villages where glove-making, chain-making, toy-making, and other home industries are carried on. Coal is mined; lignite, or brown coal, is worked in open mines; and there are flourishing glass and textile industries, and great metallurgical works,

ROSENAU, A SMALL TOWN IN SOUTH-WEST CZECHOSLOVAKIA

CZECHOSLOVAKIAN PEASANTS GATHERING STICKS IN THE FOREST

as well as the breweries which have made Pilsen world-famous. Barley, hops, and rye for brewing are grown in the lowlands, along with sugar-beet and wheat. Pigs and stall-fed cattle are important: the cattle are not put out to graze in fields as they are in Britain.

Moravia and a small part of Silesia make up central Czechoslovakia. North-west Moravia is mountainous and poor; but the lowlands of the south are rich agricultural lands, growing sugar-beet, barley, vines, wheat, and rye. Brno, the only large town, is known for its woollen manufacture and for its armament works—it gave its name to the Bren gun, which was first made there.

Eastern Czechoslovakia is the province of Slovakia. In the north are the western CARPATHIAN MOUNTAINS (q.v.), rising in the steep pyramid-shaped peaks of the Tatra Mountains. The mountains south of the Tatra are lower, and contain small deposits of gold, silver, and copper. Southern Slovakia is part of the flat, fertile Danube valley. Bratislava, the capital of Slovakia, stands on the DANUBE (q.v.). Its ruined castle used to dominate a ferry over the river, but now looks down upon a very busy modern river port.

See also Vol. I: CZECHOSLOVAKS.

D

DALMATIA, *see* Yugoslavia.

DAMASCUS. The capital of Syria claims to be the oldest of living cities. It is an eastern city of narrow streets, lined by the blank outer walls of houses with hidden courtyards, often of great beauty. There are covered bazaars in which merchants from all parts of the Near East jostle Moslem pilgrims to Mecca, and markets where Syrians and Jews haggle for bargains. There are a great many inns, as well as *khans*—high, vaulted buildings, usually lined with shops, and provided with seats and tables at which the traveller may rest or the merchant do business.

The most famous street of Damascus is Darb el Mustakim which follows the line of the old 'Street called Straight' where Ananias was sent to find Saul (St. Paul). This runs east–west for about a mile from the centre of the city to the gate leading to Aleppo.

DAMASCUS—DARB EL MUSTAKIM, ONCE THE 'STREET CALLED STRAIGHT'

There are many Jews and Christians in Damascus, but the majority of the population are Moslems (*see* Islam, Vol. I), and the city has many mosques with their domes and slender minarets. The magnificent Omaiyid mosque, famous throughout Islam, was built by Byzantine craftsmen brought to Damascus by Caliph Walid I in A.D. 708. It was restored in 1893, after it had been much damaged by fire. Its mighty halls of marble and mosaic are built round a spacious courtyard.

Much of the early fame and importance of Damascus was due to her position as the centre of trade-routes across the Syrian Desert. The fertile plain round the city is barely 500 square miles in area; so the desert is not far from the gates. To-day Damascus is still a great commercial centre for traffic—not only for the caravans that cross the desert, but also for the motor-coaches. The railway to Beirut and Aleppo passes close to the city, but not through it.

Damascus gave its name to damsons (or Damascene plums) as well as to damask silks and damascened metal. The finest silks and beautiful woollen cloth are still produced there, as well as inlaid metal-work. Lately it has become renowned as a place of learning: it has a university and big schools.

See also Syria.

DANUBE. This great river has its source in the Black Forest near the waters of the Upper Rhine, at a height of about 2,800 feet. It winds and turns for nearly 2,000 miles through the highlands of Germany and Austria, and across the vast plains of Hungary and Roumania, until at last it reaches the Black Sea in a great delta. In its course the Danube receives by means of numerous tributaries much of the drainage of the Alps, the Bohemian Forest, the Carpathians, and the Balkans. Where the main stream enters the delta, 70 miles from the Black Sea, it is 560 yards wide and 50 feet deep.

From its source to Vienna, the Danube flows swift and clear through magnificent mountain scenery. Between Passau and Krems it cuts through the hard rocks which form the southern edge of the Bohemian massif, and its bed varies in breadth according to the resistance of the rocks. On the broad reaches its banks are lined with water-meadows—often flooded in spring.

THE LOWER DANUBE CUTTING BETWEEN THE TRANSYLVANIAN ALPS OF ROUMANIA AND THE MOUNTAINS OF YUGOSLAVIA. *Royal Roumanian Legation*

The current is strong so that navigation upstream is very slow.

At VIENNA (q.v.), where it leaves the mountains, the Danube is only 450 feet above sea-level. A canal controls the course of the river near the city, and protects the low-lying parts from flooding. As the Danube enters the plain its character changes: it becomes a sluggish muddy river meandering through the level country-side. Its course divides into several roughly parallel channels, separated by swamps. Where these have been reclaimed rich pasture is found. The Danube is joined by the Morava at Bratislava, a great river port just over the Czechoslovakian border.

Near BUDAPEST (q.v.) the Danube bends sharply southwards, and flows for 200 miles through the great plain of Hungary. At Budapest the river is narrow and free from the swamps which hinder movement to the north and south of the town. The old town of Buda, which used to be protected by the Danube, is now connected with Pest on the low opposite bank by several bridges.

As it flows across the plain of Hungary, the Danube collects the drainage of the Carpathians

THE DANUBE

by means of the Tisa and its tributaries. From the south the Drava and Sava bring it the water from the Balkans. There are few towns on its banks owing to the danger from heavy floods. BELGRADE (q.v.) lies on a spur at the confluence of the Sava, above flood-level. From Belgrade the Danube flows eastwards, leaving the Hungarian plain and crossing between the Transylvanian Alps and the Balkans to the lowlands of Roumania. In this stretch the current is swift, and rapids make navigation dangerous. The narrowest and most hazardous part is called the Iron Gate, near which, on the Roumanian side, is Turnu Severin, an important river port, where barges are loaded with Roumanian oil and grain.

In Roumania the flood plain of the Danube is formed of a belt of swampy land varying from 6 to 9 miles in width, through which the river winds. Its former courses are marked by lagoons and backwaters. Communications from north to south are made difficult by the swamps and the great width of the river, which prevent bridges being built, but there is a car ferry at Giurgiu.

Beyond Giurgiu the Danube meets the hard-rock plateau of Dobrogea, which diverts it northwards. At Galati this obstacle comes to an end, and the river again turns east, and reaches the Black Sea in a great delta, an area of waste land, broken in all directions by swamps and freshwater lakes, through which run three main channels. The mud and silt carried down by the Danube are gradually extending the delta farther and farther out into the Black Sea.

The Danube is one of the busiest inland waterways of Europe, and is navigable from its mouth as far up as Ulm, midway between Munich and Stuttgart. It is connected to the Rhine by the Ludwig Canal, and to the Elbe by the Vltava Canal.

In 1856, by the Peace of Paris after the Crimean War, the river was declared open to shipping of all nations, and the 'European Commission of the Danube' was set up to improve it for navigation. In 1948 its work was taken over by a River Danube Administration which was established from the countries through which the river flows.

See also RIVERS.

DARDANELLES, *see* BLACK SEA.

DEAD SEA. This sea between Israel and Jordan has several names. It was called the Dead Sea because it is so salt that neither fish nor any kind of visible life can live in its water. But scientists now claim to have found in it a very primitive form of life, a single-cell creature—so that perhaps the Bible name of Salt Sea is more accurate. It is also called the Sea of Arabah, the Hebrew name for the Jordan valley region; and the Arabs call it the Sea of Lot, since this district is linked with the destruction of Sodom and Gomorrah.

LOOKING DOWN INTO THE VALLEY OF THE DEAD SEA

Matson Photo Service

Owing to its saltness (25 % as against the 4 to 6 % of the open ocean) floating is easy in the water of the Dead Sea, but swimming is difficult because one's chest and head are lifted high above the surface, and it is difficult to keep one's feet and legs under water to make a proper swimming stroke. It is almost always covered by a heat haze due to evaporation—which is the only means of escape for the waters brought to this strange inland lake by the River JORDAN (q.v.). This is, of course, the reason for its extreme saltness, because when the water evaporates, the salts are left behind.

The Dead Sea is 47 miles long, and from $2\frac{3}{4}$ to 9 miles wide. It lies in a 'rift valley' (*see* VALLEYS) more than 5,000 feet deep. Its surface is 1,300 feet below the level of the Mediterranean, the lowest surface known in the world, and its own depth is a further 1,300 feet down. The shores of the Sea are of shingle and stones,

and there are numerous small springs. There used to be a small island in the north part; but it has disappeared under water—a fact which suggests that the water-level is slowly rising.

Use has recently been made of the extreme saltness of the Dead Sea by the setting up of plant on its shores for the extraction of potash and other chemicals.

See also PALESTINE.

DECCAN, *see* INDIA.

DELHI. Two cities make up Delhi, now the capital of the Republic of India—Old Delhi, the historic capital of India under the Mogul Emperors, and New Delhi, built in 1911 three miles to the south of the old city, to house the Government of India. The city has altogether a population of some 915,000.

Delhi is in central north India. It is situated on the low watershed which separates the plains of the Indus and Ganges rivers—a strategic position which commands the east–west routes along both. The Moslem invaders who entered India from the north-west adopted it as their capital, and by the 16th century the Moguls were ruling the whole of north India from there. Delhi has a long history of warfare, and the ruins of five former cities can be seen on the plain near the present one. This city dates from the early 17th century, and was the capital of the Mogul Emperors (*see* INDIAN CIVILIZATIONS, Section 4, Vol. I).

Old Delhi is built of red sandstone, and is enclosed by a great wall. It can show some magnificent specimens of Mogul architecture, such as the Red Fort, with its beautiful marble palace, decorated with carvings and with inlays of precious stones. The Jama Mosque, one of the largest in the world, is a centre of pilgrimage for Moslems from all over India. Delhi was partly destroyed during the Indian Mutiny in 1857—marks of the cannon-fire can still be seen on the walls near the Kashmir Gate.

The old city is crowded and picturesque. The bazaars are famous for gold and silver filigree work, for intricate jewellery, and for embroidery, all made by craftsmen in the city. Pilgrims and gaily clad visitors from the north join the picturesque throng in the streets and bargain with the shopkeepers who sit cross-legged at their stalls. The chief modern industry is the manufacture of cotton.

When the rise of British sea-borne commerce in the 18th century reduced the volume of trade using the caravan routes over land, Delhi lost the commercial supremacy it had possessed in Mogul times. CALCUTTA (q.v.) became the capital of British India. In 1912, however, the capital was moved from overcrowded Calcutta to New Delhi, a new city specially planned by Sir Edwin Lutyens to receive it.

New Delhi is purely an administrative centre, with huge dignified buildings laid out on a spacious plan. The main buildings include the palace of the former viceroys, the Secretariat, the Council Chambers, and villas for the members of the Government and for the Indian Princes. The architecture is certainly impressive, but grandiose rather than beautiful.

In summer, the temperature of Delhi rises to over 100° F. during the day, and the heat and glare of the sun become unbearable for Europeans. In the cold season, the average temperature goes down to 58° F., and nearly to freezing-point at night.

See also INDIA.

OLD DELHI

Cattle are sacred to the Hindus and so must not be disturbed even when they decide to rest in a street *H. D. Keilor*

DENMARK: A FARM IN WESTERN JUTLAND *Royal Danish Embassy*

DENMARK. The Kingdom of Denmark consists of the peninsula of Jutland and North Schleswig and a number of islands lying in the Sound between Jutland, Germany, and Sweden. The two largest islands are Zealand and Funen. The narrow waters between these islands, the Great and Little Belts, connect the BALTIC (q.v.) with the Kattegat and the North Sea. The Little Belt lies between Jutland and Funen, the Great Belt between Funen and Zealand.

Denmark is a flat country, nowhere higher than 600 feet above sea-level. Narrow inlets twist into Jutland from both sides so that no part is more than 50 miles from the sea, and in fact the two northern provinces of Jutland are really on an island narrowly separated from the mainland. Wherever crops can be made to grow, or cattle, pigs, and poultry can be fed, the Danish farmer and his wife settle, producing food, not only for themselves but for export. There has been much reclamation and drainage along some parts of the coast; in other parts wastes of wind-blown sand have been planted with grass and pine-trees to bind the soil in place. Most of the great beech forests and heathery moorland that once covered broad stretches of the country have now been cleared and brought under the plough.

Though Denmark is a land of small farmers (of its 150,000 farms only 20,000 are bigger than 100 acres), their farming is so well organized that a national standard of produce is maintained. Dairying and pig-rearing are the main types of farming, the buttermilk left after butter-making being used to feed the pigs. Grain is imported for cattle-feeding and for poultry-raising.

The Danish climate is well suited for dairy-farming, as an abundant rainfall encourages the growth of good pasture. The climate, in fact, is very like that of Britain, though winters tend to be colder and summers warmer. Denmark is a very windy country—Danes are said to be recognizable all over the world by their habit of grasping their hats instinctively as they step out of their houses!

The population of Denmark is just over four millions, a quarter of whom live in and near COPENHAGEN (q.v.). Copenhagen is the only

DENMARK

ge town, and the centre of Danish industry. ther important towns are Aarhus, on the east ast of Jutland, Aalborg, on an estuary to the rth of Jutland, and Odense, where HANS NDERSEN (q.v. Vol. V) was born, on the island Funen. The FAEROE ISLES (q.v.) in the north lantic are part of Denmark, as is also the rocky land of Bornholm in the Baltic Sea, an island uch beauty that it attracts many visitors.

See also Vol. I: DANES.

DENSITY. This is the weight—or, more curately, the MASS (q.v.)—of any substance comparison with its volume: that is to say, e number of pounds per cubic inch or grammes per cubic centimetre. Different substances have different densities. For instance, lead has a reater density than oak, while that of water lies omewhere between the two, being far less than hat of lead and just more than that of oak. This why lead sinks in water, whereas oak just floats. The density of cork is even less than that of oak, nd so cork floats better still (*see* ARCHIMEDES, Vol. V).

When comparing the densities of different ubstances, it is convenient to have a standard gainst which to measure them. In the case of solids and liquids, the standard chosen is water; gases, being so much lighter, are measured against either air or hydrogen. This comparison gives a figure for each substance, which is called its Relative Density or Specific Gravity. For instance, cast iron is seven and a half times as heavy as water, and so its Specific Gravity is 7·5. Because 1 cu. cm. of pure water weighs (under standard conditions) exactly 1 gm., the density of any solid or liquid stated in grammes per cubic cm. gives the same figure as that in a table of Specific Gravities.

If a substance changes its volume—that is to say, if it shrinks or expands—evidently it must change its density too. For instance, if we were to put a piece of oak under a powerful press and squeeze it down to half its thickness, since its weight would remain the same, its density would be doubled: in fact its Specific Gravity would then be greater than that of water, and it would no longer float. Now change in volume can follow either from change in temperature (*see* HEAT, Section 3) or from change in PRESSURE (q.v.). So it follows that the density of any substance must depend on its temperature and pressure. For this reason, in calculating the Specific Gravity of gases, standard (or normal) temperature and pressure (N.T.P. for short) are used—0° Centigrade, and 760 mm. of mercury on the barometer.

With solids and liquids, since small changes in the pressure of the atmosphere do not affect the volume enough to matter, only a standard temperature, 4° Centigrade, is taken as a rule. The reason why 4° is taken in this case, instead of 0°, is interesting. Almost all substances shrink as they grow cooler, and expand as they get warmer. But if water were to follow the usual rule and decrease in volume as it grew colder towards 0° C., at which point it freezes, its density would increase and it would therefore sink through the warmer water below (since in a frost it is the top layer which gets chilled first). Then we should get lakes and ponds freezing from the bottom upwards. That would mean we should get practically no skating—and many fish and other creatures which can live quite happily for months at a time in the water under the ice would find life much more difficult. But water is one of the very, very few substances which do not behave in that way. As it cools from 4° to 0° C., instead of contracting, it expands: its density therefore decreases—and so the coldest water stays on the top to form ice. The point at which it begins to behave in the normal way and expand as its temperature rises is 4° C., the smallest volume which water ever occupies. This is the standard temperature chosen for calculating the Specific Gravities (or Relative Densities) of solids and liquids.

DENUDATION, the 'making bare' of the surface of the earth, is carried out by three processes of nature, known as 'weathering', 'erosion', and 'transport'.

1. WEATHERING. Rocks, even very hard rocks like granite, are affected to some extent by atmosphere and climate. The processes of nature by which rocks are changed or broken up are grouped together as 'weathering'. It is convenient to divide weathering into chemical and physical (or mechanical) weathering.

(*a*) Chemical weathering is chemical change brought about in the MINERALS (q.v.) which make up a rock, as the result of the gases in the air and/or the presence of moisture. For instance, sulphide of iron (marcasite), which is found in silvery crystals in the Oxford and

Kimeridge clays, is readily oxidized (made rusty) when it is exposed to the moisture of the air. Indeed, the heat generated by the oxidation of iron sulphide has been known to set fire to shale which was slightly oil-bearing. This happened at Lyme Regis on 19 January 1908 when a cliff fell, and smoke began to issue from the mound of debris—with the result that mistaken reports of a 'volcano' circulated in the newspapers! Finely divided particles of iron sulphide give clays a bluish colour; but near the surface of the earth, where this oxidation can take place, clays are coloured brown owing to the presence of other iron salts.

Perhaps the gas with the most widespread effect on minerals is carbon dioxide, which is always present in the air to the extent of about 0·04 %. Carbon dioxide, when dissolved in water, forms a weak acid which has effects similar to those of vinegar or other natural acids, though to a less degree. Many minerals are slowly decomposed by carbonic acid into other substances, which are often soft and powdery and easily removed by wind and rain. This acid has the greatest effect on limestone and

ROCKING STONES, HOWDEN MOORS, YORKS
Weathered by long exposure to wind and rain
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other forms of calcium carbonate, which slowly dissolve in carbonic acid to form calcium bicarbonate. This substance is generally present in drinking-water and is one of the causes of 'hardness' of water.

Water in limestone districts is usually particularly hard: in extreme cases the water is so charged with calcium bicarbonate that, wherever it drops or trickles sufficiently slowly to enable some of the dissolved carbon dioxide to escape, the calcium bicarbonate reverts to calcium carbonate, which is deposited as a chalky layer on cracks in the rocks or in solid objects over which the water trickles. Objects coated in this way are said to be 'petrified' or turned into stone. This is the way in which 'stalactites' and 'stalagmites' are formed in CAVES (q.v.), the caves usually having resulted from the gradual dissolving away of limestone by underground water containing carbon dioxide. Other chemicals which decompose the minerals making up a rock are produced by decaying plant or animal matter.

(*b*) Physical or mechanical weathering includes the straightforward dissolving by rainwater of all kinds of soluble material in rocks, especially salts of sodium, potassium, magnesium, and iron—such as sodium chloride (common salt) or potassium nitrate (saltpetre). The removal of such salts has, of course, the effect of weakening the rocks and making them more easily disintegrated and broken into fragments by the other agencies of weathering—sun, wind, rain, frost, and ice. The effect of the sun is felt most strongly in hot deserts, as during the day the rocks expand, and then, when the temperature falls suddenly at night, they contract so rapidly that they split and break off wherever a crack has developed during the expansion. Soldiers serving in the Egyptian desert are said sometimes to have mistaken at night the noise of splitting rocks for the rattle of machine-guns. The sun, in such regions, also affects rocks by causing them to 'sweat out' to their surfaces some of their dissolved salts. This gives them the shiny surface called 'desert varnish'.

Wind is an important agent in physical weathering. Its action is greatest in desert regions: there it gathers up sand and uses it as sand-blast, and wears away the softest strata, often undermining harder rocks, which rest above. The grains of sand, worn by continual friction, grow smaller and smaller until they become dust, which is carried on the winds and deposited as 'loess' very many miles away. Fine sand, for instance, from the deserts of central Asia is deposited on the river plains of China (*see* ROCKS, Section 3 *a*). In temperate climates

SEA EROSION AT PAKEFIELD, NEAR LOWESTOFT

The sea has cut away the cliff until houses—once some distance from the cliff edge—have collapsed

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the weak places in a rock or even in a brick wall are penetrated by wind and rain, and the effects of such prolonged exposure to the elements can be seen in the pictures above.

Frost has its strongest effect when porous rocks have had their cavities and cracks filled with water—for instance, after heavy rain. During severe frost the water, turning to ice, expands and exerts great pressure, widening crevices and producing ice crystals even in microscopic cavities. When it is remembered that water increases its volume by more than one-tenth in freezing, it will be seen how powerful this pressure can be. When the thaw sets in, mineral crystals, particles of rock, and even pebbles or large stones which have been loosened are dislodged by gravity, wind, or rain. Anyone who has noticed the spongy nature of a gravel path when first the thaw sets in after frost will realize how much the top crust of trodden gravel has been lifted by the ice underneath. In regions of prolonged winter frosts, as in the mountains of Switzerland, the effects are not apparent until spring comes and the ice in the lower parts of the mountains melts. Then blocks of stone, which have been cut off the mountain walls by the ice, tumble into the valleys below.

2. Erosion. This word, taken literally, means 'eating away'. It is impossible to separate erosion and weathering completely, since the sand-blast of the desert and the driving rain of a storm are eroding no less than weathering forces; but it is usual to restrict the term erosion to actions which more closely fit the exact meaning of gnawing away. Rain, running water, waves, and moving ice are the main agents of erosion. The great world problem of erosion in relation to human settlement and agriculture is dealt with separately (*see* Soil Erosion).

Running water erodes by the agency of particles of sand (as in a streamlet), pebbles (as at the bottom of a rather slow river), or large stones (as in the case of a vast mountain torrent). Sometimes, in swiftly running streams, large stones carve out 'pot-holes' even in hard rock. The sea uses stones as one of its weapons in its assault upon shores and cliffs. Storm waves hurl tons of water with enormous force against the

shore beds, thus discovering any hidden cracks or flaws. The stones break the minerals of crystalline rocks and bore into sandy and muddy rocks; the waves, as they suck back, scoop out the loosened material. Marine erosion, as this action of the sea is called, has a great effect upon the surface of the earth in course of time.

In some places the sea deposits land, as, for instance, the shingle beds of Dungeness and the long stretch of Chesil which links Portland to the mainland. But, in general, the sea wears away much more than it builds. On the east coast of England its effects have been spectacular: the force of the sea has worn away the soft cliffs so that, even in a few centuries, churches and villages, once some distance from the coast, have been washed away. When the sea has torn down the cliffs, it breaks up the stones and grinds smaller the sand grains, all the time carrying the smallest material farther out on to the bed of the shallow coastal seas.

Moving rivers of ice, i.e. GLACIERS (q.v.), carry along with them stones of all sizes which wear away the ground beneath and beside the ice. They break off irregular jutting rocks in their path and burrow out the softer layers, whilst smoothing and polishing the harder ones (*see* GLACIATION).

3. TRANSPORT. The third process of denudation is that which actually moves material from one place to another. Weathering decomposes minerals and disintegrates rocks; erosion gnaws rocks away (especially where they have been affected by weathering) and pulls down cliffs and river-banks; then the forces of transportation get into action and carry the fragments away. The main transporting force is running water—rills, streams, rivers, and sea currents. Everyone can see rills carrying sand, mud, and pebbles down a hill-side, or stones being bumped along a mountain stream, or a river turbid with mud and sand after heavy rain. These are all part of the great process whereby the surface of the earth slowly but surely finds its way to its resting-place in the sea.

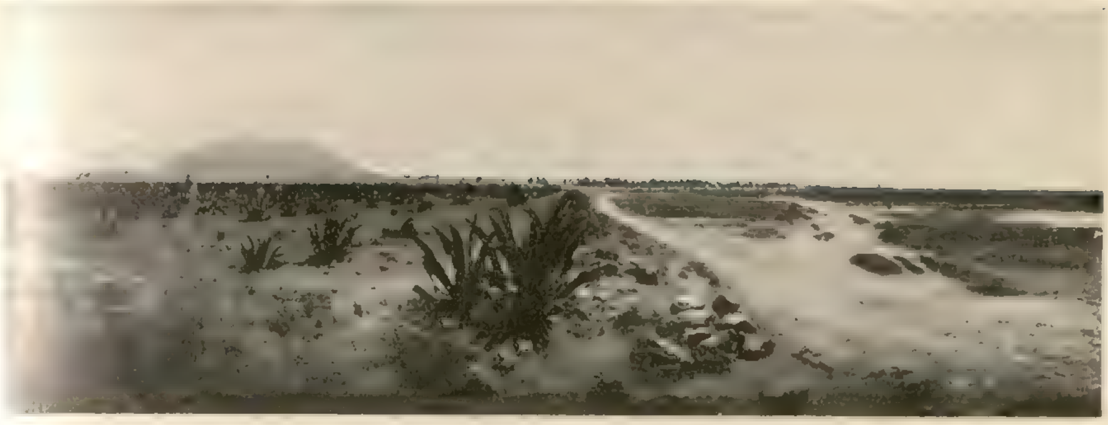
The transport of materials by moving ice has already been described. Animals, earthworms in particular, also play a slight part in transportation. Worms carry to the surface subsoil which they eject from their bodies as worm-casts; these turn to powder, which is easily washed or blown away. Darwin estimated that in cultivated land earthworms spread fine earth over the surface at the rate of 3 inches in 15 years. In addition, the vertical holes made by the worms let water more easily into the soil, to wash some of it away. Other animals which help the wearing away of the land are those living in burrows, such as moles, rabbits, foxes, and badgers.

See also EARTH, HISTORY OF; MOUNTAIN BUILDING; GLACIATION; ROCKS, Section 3; SOIL EROSION; MINERALS.

DESERTS. There are vast areas of the earth's surface, called deserts, where there is almost no rainfall and, consequently, little or no vegetation. These great deserts are found in the interior of the continents of Africa, Asia, and America. The desert belt stretches eastward from the SAHARA (q.v.) across Arabia into central Asia, where it is known as the Gobi Desert. To the south, across the Himalayas, is the Desert of Sind, which occupies thousands of square miles in the north-west of India. In America there are desert tracts east and south of the Sierra Nevada mountains. In the southern hemisphere, the Atacama Desert lies on the west of South America, and the Kalahari Desert in South-West Africa. The Victoria and Sandy Deserts occupy the interior of Australia. Around the North and South Poles lie great wastes of ice and snow called 'ice deserts', where the temperature is below freezing-point all the year round, and nothing can live or grow.

Deserts are generally found in the interior of continents, because there the lands are so far from the sea that the WINDS have lost all their WATER-VAPOUR (qq.v.) before reaching them. In the northern hemisphere, the north-east trade-winds have to blow across thousands of miles of land surface before reaching the centre of Africa or Asia. In the southern hemisphere, the prevailing south-east trade-winds blow over the ocean, and bring rain to the eastern parts of the continents of Africa and America. But towards the west the rainfall lessens; and narrow strips of desert, such as the Atacama Desert, are found on the western edges of the continents.

The barren dryness of some deserts is intensified when mountain barriers lie between them and the prevailing moisture-bringing winds. These are called 'desert basins'—the Tarim Basin in western China and the Great Basin of North America being notable examples. These basins are sometimes called 'cold deserts' because they are usually at a high altitude and are intensely cold in winter.



CACTUS AND POOR SCRUB ON THE DESERT PLATEAU OF MEXICO
Royal Geographical Society

THE STONE WASTES OF THE GOBI DESERT IN CENTRAL ASIA
Royal Geographical Society

ROCKY RIDGES IN THE SANDY PLAINS OF THE CENTRAL AUSTRALIAN DESERT
Australian News and Information Bureau

All deserts, wherever they may be, are dry. They also have a high range of temperature—that is to say the differences between day and night, and summer and winter temperatures are very great. The dry soil takes heat quickly from the sun, and the air near the ground heats up as the sun rises into the sky. But after sunset the dry soil gives up its heat equally quickly, and the air temperature drops rapidly. During the day, the intensely hot air rising from the earth's surface often causes a shimmering haze to develop, which, when seen from a distance, may play queer tricks on the eyes. This is the MIRAGE (q.v.) which has often deceived thirsty travellers in the desert. During the night, the air is cold and clear, and the stars are visible, so that conditions are favourable for travelling. In the desert basins the winter temperature often falls below freezing-point, as heavy cold air rolls down the mountain sides into the deserts.

When a wind rises in the desert, it lifts the dry soil and carries it along in swirls, called 'desert devils'. When the wind is strong, a swirl of hot air at over 100° F. may rise, so laden with choking clouds of hot dust and sand that it is impossible to see through it more than a few feet ahead. This sand-storm is called a 'simoom'.

Deserts are not always covered only with sand, although sandy deserts are the best known. Sometimes the surface is covered with bare rock or with boulders. The rocks become worn smooth by the polishing action of wind-blown sand, and large rocks are chiselled away at their bases, because the force of the sand is most intense near the ground. The sands of the desert do not lie in a flat plain, but are blown into ridges and waves by the wind. Crescent-shaped sand-hills, called 'dunes', are formed, with long gentle slopes facing the wind, and steep slopes away from the wind. Sand moves up the gentle slope and falls down the sharp slope, so that the dunes move slowly like ocean waves in front of the wind. The shape of a sandy desert is always changing, and so there are no permanent land-marks to guide travellers. People, therefore, generally travel by night when the air is cool, finding their way by the help of the stars: most desert people are knowledgeable about the stars. Travel is sometimes easiest along the dried-up beds of streams, called *wadis*, which have steep sides, often 20 or 30 feet high, and are sheltered from wind. The *wadis* have often a firm walking surface (*see* DESERT TRAVEL, Vol. IV).

Occasionally, at irregular intervals, often years apart, rain falls in the desert. Then the *wadis* are full for a few days, and desert plants, which are able to lie dormant for years, spring into life when water reaches them.

There are spots in the desert where underground water comes to the surface in springs, and there the land is always well watered and fertile. These are called 'oases' and they are often surrounded by miles of barren country. Oases are found in well-defined chains, not far from the foot of mountains, as in the Sahara and the Tarim Basin, and they are often large enough to support permanent settlements. Date-palms, maize, millet, cotton, wheat, and melons grow in them—for the desert soil, when supplied with water, is especially fertile, the salts needed by the plants having accumulated through years of drought (*see* DESERT PLANTS, Vol. II).

There are often dried-up lake-beds in deserts, and these contain deposits of salts, like borax, nitre, and phosphates, which may be dug out and exported as fertilizers to the food-producing regions of the world. Thus even the most barren regions can make some contribution towards the production of food in other parts of the world.

See also COLORADO DESERT.

DEW. There has been much argument as to whether dew rises from the ground or condenses out of the air. The truth appears to be that while all dew undoubtedly condenses out of the air, much of it—and often the greater part—does so immediately after rising out of the ground as WATER-VAPOUR (q.v.). The amount of moisture which air can hold depends on its temperature: the warmer the air, the more water-vapour it can carry. So if moisture-laden air is steadily cooled, there comes a point, called 'dew-point', at which it must begin to get rid of the excess of water-vapour by condensation. The ground at night usually loses heat quickly by radiation, and if there is little water-vapour in the air to act as a blanket, and no clouds to reflect this radiated heat downwards again, the ground, and the leaves and grasses on it, may become so cold that their temperature falls below the dew-point of the air in contact with them. When this happens, dew is deposited on them in just the same way as moisture condenses on the outside of a glass filled with iced water. If there is any wind, this will keep the air stirred

·· and so prevent the local cooling that leads ·· dew.

We see, then, that the most favourable ·nditions for dew are clear still nights, when ·· air is comparatively dry—the sort of weather, ·· ·act, that is least likely to bring rain. This has ·l to the country sayings:

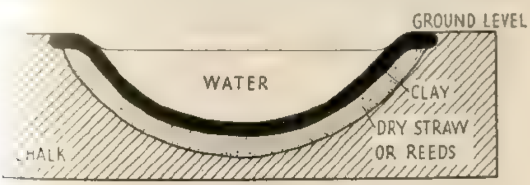
When the dew is on the grass
Rain will never come to pass;

·l the opposite:

When the grass is dry at morning light
Look for rain before the night.

·iese weather conditions are most usually met ·th in autumn, when the bare twigs and ·iders' webs often display a wonderful tracery ·diamond spangles. If the temperature is as ·v as freezing-point, the dew will be found in ·e form of 'hoar-frost' (*see* FROST).

Dew-ponds, which derive their water-supply ·m dew, have been made in suitable high-·ing ground, such as down-land, ever since ·ehistoric days. Some EARTHWORKS AND HILL ·RTS (q.v. Vol. I) appear to have relied on ·em, as do some sheep-walks to this day. The ·ret of making them is now known to very few ·ople; but it seems to be based on providing



SECTION OF A DEWPOND

very efficient insulation against the warmth of the ground beneath, layers of straw being covered with well-trodden clay.

DIAMOND. Diamonds are probably the most widely known and admired of all gem stones. Until the early 18th century India was the sole source of supply, the diamonds being obtained from the gravels in the beds of rivers. The marketing town was Golconda, near the River Kistna in Hyderabad. About 1725 diamond fields were discovered in Brazil; and then, in 1867, the richest fields in the world, the South African fields, were discovered near the site of Kimberley. The early South African workings were on the surface; but now there are shafts


WASHING RIVER DEPOSITS FOR DIAMONDS IN BRAZIL
Ewing Galloway, N.Y.

and mines and elaborate machinery. Diamonds are found in other parts of Africa, and also in Australia and British Guiana.

The conditions under which diamonds have been formed are still unknown, though it is clear that there must have been great pressure. Chemically a diamond is very pure carbon and, when found, has usually little beauty. It is the hardest known substance; but as it is also very brittle and has excellent cleavage, it can be split or 'cut'. Small diamonds have been found in meteorites (*see* METEORS).

Though some coloured diamonds have become famous because of their size and beauty, the finest stones are either colourless or blue-white. Black diamonds and poor specimens of white diamonds are very important in industry for cutting, drilling, and engraving. London is the centre of the rough diamond industry. The cutting and polishing of diamonds is also important there, as well as in Antwerp, Amsterdam, St. Claude in France, and in the U.S.A.

One of the most famous diamonds is the Koh-i-noor (Mount of Light). In the 16th century it was the property of the Mogul Emperors. Later it belonged to the East India Company. Eventually it was presented to Queen Victoria. The largest known diamond,

the Cullinan, weighed about 3,025 carats, or over a pound and a quarter, when found. It was presented to King Edward VII, and was cut into several stones, two of the largest of which are in the British Crown Jewels. The largest coloured diamond is the greenish-blue Hope diamond. This was bought in India in 1642 by a French jeweller and sold to Louis XIV. It is supposed to bring ill luck to its owner. The other famous coloured diamonds are the apple-green Dresden diamond and the orange Tiffany diamond.

See also Vol. XI: JEWELLERY.

DODECANESE. The name means 'Twelve Islands' though it has not always been applied to the same islands. In the 13th century it referred to the islands in the eastern Mediterranean, lying between Samos and Rhodes, which had belonged to the Knights of the Hospital of St. John. To-day the Dodecanese are the islands in the Aegean Sea, which lie between the coast of Asia Minor and the islands of Greece. There are fourteen main islands, and a great many islets. Rhodes, the largest, has an area of about 500 square miles, Carpathos has 116, Cos 110, and all the rest less than 50 square miles each.

All the islands are hilly and, except for Rhodes, Cos, and Nisyros, rather infertile. Formerly they were all forested; but neglect, fires, and goats have destroyed practically all the trees, except on Rhodes, Cos, and Carpathos, where there are pines, junipers, cypresses, and oaks. The hills of the other islands are largely covered with evergreen scrub, such as juniper, sage, lavender, thyme, and myrtle. Sheep and goats are grazed in large numbers everywhere, and small plots and terraces bear wheat, barley, oats, and various Mediterranean fruits. Potatoes and tomatoes are usually planted between the fruit-trees. Considerable quantities of honey are produced and exported.

THE DODECANESE

RHODES: THE HARBOUR FORTIFICATIONS. *Cooke*

Many of the inhabitants are fishermen, and octopuses are caught in traps—often baited with small pieces of mirror. Sponge-fishing is not the great industry it once was, as many of the divers have emigrated to Florida, in the United States of America, where they can make a better living.

The people, most of whom are Greeks, live in small villages. These are often built on the spur of a hill for easy defence. The streets are narrow, roughly paved, and often so steep as to be just steps. The houses have flat roofs on which the whole family sleeps in the heat of summer. The main buildings are usually grouped round a small square. Throughout the country-side there are many small churches, as well as windmills with huge canvas sails and low round towers, thatched or roofed with tiles.

On Rhodes and Cos there are fortified walled towns. The town in Cos (also called Cos) has a castle built by the Knights of Rhodes to guard the harbour. Rhodes has two towns—Lindos and Rhodes. Lindos is built at the head of a

ll bay, protected from the sea by a high ky promontory, on which stands its castle.

he city of Rhodes (55,500 inhabitants) is at orthern tip of the island. It is an ancient for the island was colonized in very early by Phoenicians and by Greeks. Rhodes was founded in 408 B.C.; but there is little e ancient city left now. The famous Colossus hodes, an enormous bronze statue of the God, 107 feet high, was overthrown by an thquake in 224 B.C. after standing for 56 s. Nothing now remains. The many lovely dings still existing date from the 14th and centuries, when the Knights Hospitaller l the island. They captured the city in 1310 l held it till 1523 when they were expelled by Turks (*see* KNIGHTS, ORDERS OF, Vol. I). On high ground to the north-east of the city the ruins of the Cathedral of St. John and of Palace of the Grand Master of the Knights of John. From the Palace to the harbour runs famous 'Street of the Knights' with its lieval stone houses. Some of these houses ry the inscriptions and armorial bearings of countries to which their inmates belonged. of the finest is the Hostel of France which rs above its beautiful carved doorway an ription relating to the Grand Master mboise, 1492. The fortifications and castle the city are still in good repair. In 1920, ssession of the Dodecanese passed from Turkey Italy. After the Second World War the ands were ceded to Greece.

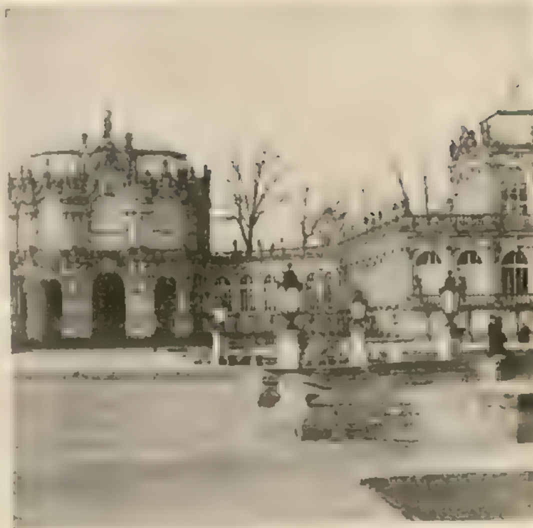
See also GREECE.

DOLDRUMS, *see* WIND.

DOLOMITE, *see* ROCKS, Section 3 (*e*).

DRESDEN, in Saxony, is an important eastern German manufacturing centre and traffic junction, with a population of well over half a million inhabitants. But the real importance and fame of Dresden rest on its cultural institutions—schools of art and science, one of the best operas in the world, magnificent collections of art treasures, and fine buildings dating principally from the Baroque and Rococo periods. It is often called the 'Florence of the Elbe'.

Dresden was originally a settlement of Slav fishermen on the River Elbe. In the 13th century it became a German city, and from the end of the 15th century was the capital of the Dukes of Saxony and one of the most lavish courts in Europe. It was at this time that the arts, particularly architecture and painting, began to flourish. A second period of greatness and expansion occurred during the first half of the 18th century, when the rulers of Saxony were also kings of Poland.



A PAVILION IN THE ZWINGER, DRESDEN. *Keystone*

From this period dates the Zwinger—a spacious courtyard, flanked by halls, porticoes, and arcades, intended to be the vestibule of a palace. It is situated in the old part of the city near the river and is surrounded by wide terraces and public gardens. On one side stands the fine 19th-century Museum, which houses, among other treasures, a magnificent collection of pictures, including the famous Sistine Madonna by Raphael. The city also possesses some outstandingly beautiful churches and palaces. Much of old Dresden was, unfortunately, damaged by air-raids in the Second World War.

The famous 'Dresden china' is not, in fact, made at Dresden, but at Meissen, an old Saxon town not far away. It depended, however, on the patronage of the Dukes and wealthy nobles of Dresden.

See also GERMANY.

DUBLIN. The capital of Eire (Republic of Ireland) was important in Celtic times. In the 9th century Norse pirates settled there and ruled the district, until in the 12th century Richard Strongbow, Earl of Pembroke, came to Ireland

DUBLIN: QUAYS ALONG THE RIVER LIFFEY
Irish Tourist Association

to push his fortunes, captured Dublin, and married the daughter of the King of Leinster. King Henry II, however, took the city from him and held it against the Irish tribes. In the long story of English-Irish relations, Dublin was always the prize.

The city, which has a population of 691,500, stands on a fine harbour in Dublin Bay. The River Liffey runs through the city from west to east, and is crossed by a number of bridges. Both banks are lined by quays and warehouses. The port of Dublin is at Dun Laoghaire, a few miles from the city.

Dublin Castle, around which the old city grew, was the headquarters of the English administration from the 13th century until 1922; it now houses a museum and various government departments. The Dáil Eireann, the Irish House of Commons, meets in Leinster House in Kildare Street. Dublin has three cathedrals: two Protestant—the one founded by the Danes and the other by the Normans—and the Catholic cathedral which was built in the 19th century when the laws denying freedom of worship to the Catholics were removed. The University of Trinity College was founded for Protestants in the last year of Queen Elizabeth; the Catholics did not gain a university of their own until the National University was founded in 1908, with its centre at University College, Dublin. Much of Dublin's charm is to be found in her beautiful Georgian terraces and squares—such as Fitz-William Square and Merrion Square. In the 18th century, when Dublin was one of the gayest cities of Europe, many of these great houses, with their beautifully proportioned rooms, tall mahogany doors, and fine marble overmantels, were the scene of brilliant assemblies; but most of them have now been converted into consulting-rooms, offices, or flats. Almost the first impression of the visitor to Dublin is that of faded glory, a sense that the capital is living in its past.

In Phoenix Park, which covers nearly 2,000 acres in the north of the city, there is a famous race-course and a zoo. To the south, the suburbs of Dublin reach the foot-hills of the purple Wicklow Mountains, a range which runs through County Wicklow into Wexford.

See also IRELAND.

DUNES, *see* DESERTS.

DUTCH EAST INDIES, *see* EAST INDIES.

E

RTH. Much of the Earth's past can only be ecture; but there is a great deal of exact vledge about its present state. It was once ved that the Earth was flat (some cranks maintain it to be so) and that the Sun, Moon, l stars were fixed in 'crystal spheres' revolving id it in a complicated way. But we now ow that it is a globe, revolving on its own axis roximately once in 24 hours and also moving d the Sun on an almost circular path roximately once in a year. (For more exact ils of these rotations *see* CALENDAR.) Its rage distance from the Sun is 93 million miles, the plane in which it revolves is called the ne of the ecliptic'. The Earth's axis is at degrees to this and stays practically parallel ts original direction all the time (*see* Fig. 4). is the poles alternately face towards and away m the Sun, causing spring, summer, autumn, winter—except in regions round the uator, where seasonal changes are too slight oe noticed. The greater heat of summer and d of winter are due not to the lesser or greater tance from the Sun, but to the varying angle which the Sun's rays pierce through the atmosphere, and partly, also, to the longer and shorter hours of daylight.

In addition to these two movements of the Earth there is a third. Anyone who has watched a spinning top will have noticed that, as well as spinning, its axis often moves slowly round as in Fig. 1. In just the same way the Earth's axis gyrates once in every 25,800 years (*see* ASTRONOMY, MODERN, Section 4). This motion is called 'precession', and it is caused by the gravitational pulls of the Sun and Moon on the Earth's equatorial bulge. For the Earth is not an exact sphere—even allowing for surface irregularities: it is slightly flattened at the poles and has a slight bulge round the Equator.

Through the poles the circumference of the earth is 24,860 miles; at the Equator, 24,902 miles. Its mass is 5,876 million, million, million tons, and its volume 259,600 million cubic miles. The highest mountain (Everest) rises 29,002 feet above the sea, and the greatest known depth (Swire Deep, off the Philippines) is 34,430 feet below. The average height of all land is 2,700 feet above sea-level; but only 29·22% of the Earth's surface is land. Round much of this there is a broad and gently-sloping rim—the continental shelf—and the seas above this shelf, being less than 100 fathoms (600 feet) deep, are known as the shallow seas in contrast with the deep oceans. There is evidence that the true boundary between continents and oceans is along the terraced front of the continental shelf and not along the present shore line, since the ocean beds are different from those of the seas, being underlain by a heavier rock than the crustal rock of the land (*see* OCEANS).

It seems that below the solid crust of the Earth there is still a layer or 'sub-crust' which is sometimes, if not always, molten or semi-molten. Evidence for this is supplied by VOLCANOES (q.v.) and other outpourings from the Earth's crust. These indicate that this semi-molten layer is probably composed of a rock known as 'basalt'. Again, tests taken in mines, borings, and tunnels

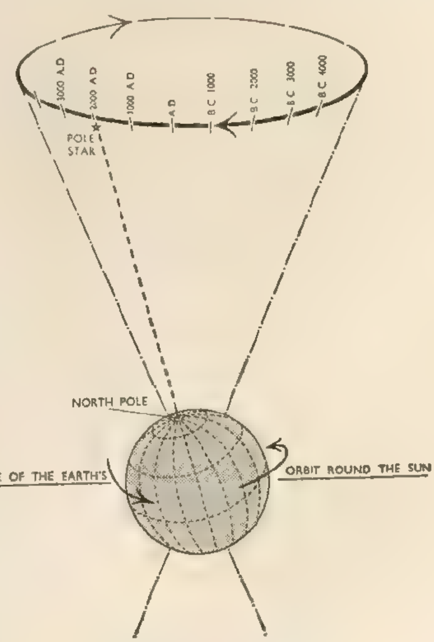


FIG. 1. PRECESSION

As the earth rotates, its axis makes a slow wobble in the opposite direction, just like the axis of a spinning top. This slow movement traces out a circle in the heavens above once in 25,800 years. During the last few thousand years, the north celestial pole has been approaching the Pole Star, and is now close to it; in future centuries it will move farther away from the star.

show that the temperature inside the Earth increases with the depth by about 100° F. for every mile of descent—though as the Earth can only lose its heat at the surface, it is unlikely that the temperature continues to increase as rapidly as this. The only known source of heat within the Earth's crust is the gradual break-up of radioactive minerals (such as uranium and radium); but as only one-fifteenth of this heat is lost at the Earth's surface it seems that the temperature must be gradually rising—a process which may have catastrophic effects at some distant date.

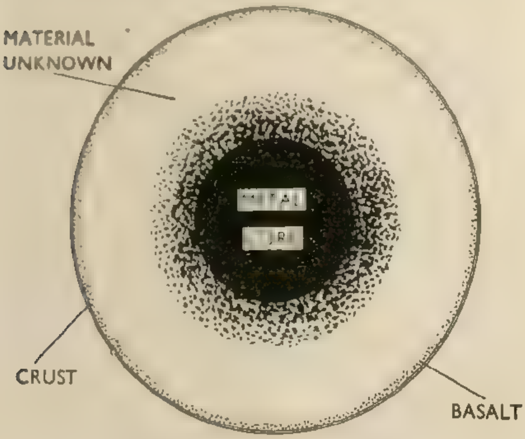


FIG. 2. SECTION OF THE EARTH
The radius of the core is two-fifths that of the earth; the basalt is perhaps 50 miles thick and the crust 19 miles

We can also learn much about the Earth's interior from the study of EARTHQUAKES (q.v.). The vibrations that an earthquake sets up travel both round and through the earth. From careful analysis of the different kinds of vibrations recorded by instruments at different distances from the scene of the earthquake, and of the rates at which these vibrations have travelled, it is clear that at an average depth of 20 miles below the Earth's surface there is a layer of quite different material, the sub-crust, which extends slightly more than half-way to the Earth's centre and becomes denser with depth. At the centre of the Earth is a sphere of material which must have quite different properties again—because it does not transmit certain of the waves set up by an earthquake. The average density of the Earth is 5·517 grammes per cubic centimetre; but as the density of the outer layers is considerably less than this, it follows that this central 'core' must have a density much greater.

For several reasons this core is believed to consist of iron: iron is by far the most abundant of all the heavier metals in the Earth's crust, and it becomes more plentiful as the depth increases; the spectroscope (*see* COLOUR) shows it to be one of the most abundant metals in the Sun, and, lastly, all meteorites or 'shooting stars' (which are believed to be fragments of the same material as planets) contain a lot of iron (*see* METEORS). The temperature at the centre of the Earth is possibly so high that the iron would be in the state of gas (it boils at 3,000° C.), were it not for the stupendous pressure existing there. The state of our ideas at present is best shown by Fig. 2.

Though we know so little about the interior of the Earth, we know a great deal about the crust and layers immediately below. As has been said, the land masses are floating on a layer of semi-plastic rock, and, accordingly, they are subject to the ordinary laws of flotation and balance. In other words, just as the greater bulk of a floating iceberg lies below the surface of the water, so by far the greater bulk of a continental mass must be below the depth of the ocean bed (*see* Fig. 3). And as the under layer is plastic, if pressure upon it is increased in one region, it is relieved by upward movement in some other region. This theory of balance explains the upward movement of newly formed mountains (*see* MOUNTAIN BUILDING), and is partly the basis of the theory of CONTINENTAL DRIFT (q.v.)—indeed, it makes intelligible a very great number of geological facts.

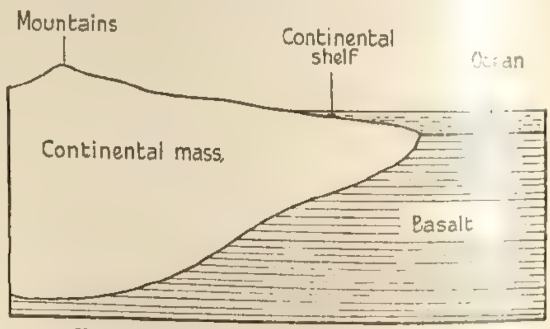


FIG. 3. SECTION OF THE CRUST OF THE EARTH

To observers on the Moon, the Earth would look much larger than the Moon does to us, and would seem almost fixed in the heavens—since it is always the same face of the Moon that we see. Even without telescopes, they would notice our rotation, because they would be able to distinguish land and sea, the great areas of white

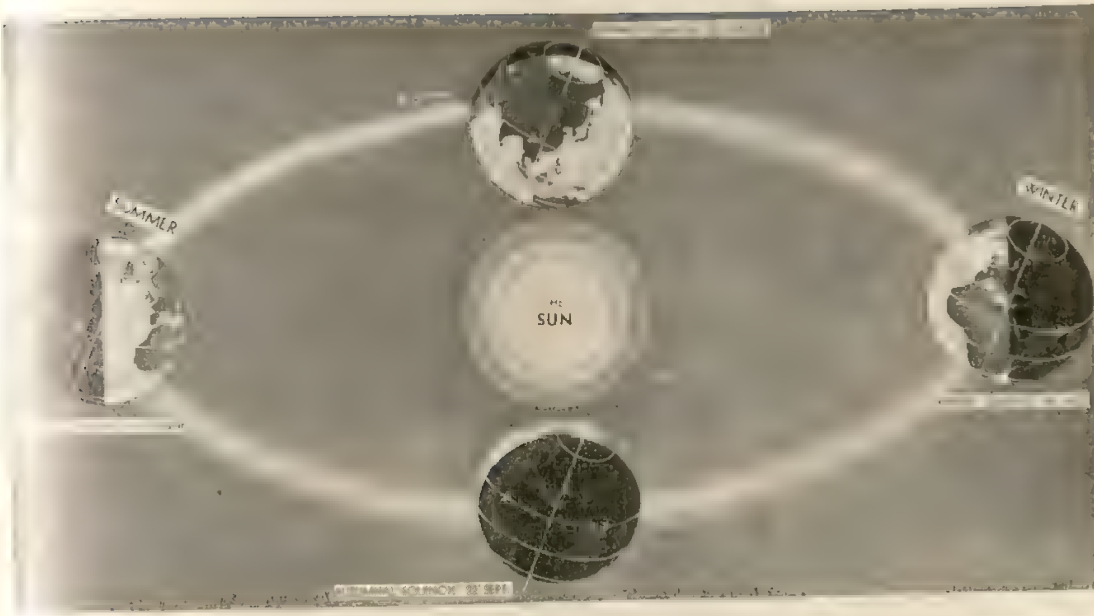


Fig. 4. THE SEASONS

ıis diagram the positions of the land areas of the world are of no significance as they are constantly changing with laily rotation of the earth. In summer, the earth's axis slopes towards the sunshine in the northern hemisphere. :s in temperate latitudes enjoy a longer period of daylight, and in the polar regions the sun never sets. In winter, arth's axis slopes away from the sunshine, the nights become longer in temperate latitudes, and in the polar regions ontinuously dark. At the equinoxes, day and night are of equal length throughout the world. Places in the southern isphere have their seasons at opposite times to those in the north.

ınd the poles and, in places, seasonal changes; th telescopes, they could discover a great deal re. Our rapidly changing clouds would erest them especially. A description of the rth in a book written by the Man in the Moon ıght read:

'Cloud assumes diverse forms, always bright nd white except near the ends of the day. There are sheets unbroken for hundreds of miles, torn and ragged areas, and thin translucent films. By observation of shadows it is known that clouds usually hang clear of the Earth's surface. Moving shadows can be used to measure the undulations of the land, and the drift of the clouds themselves has enabled us to obtain a detailed idea of the main wind-streams. A variation in the size and shape of the Sun's reflection from Earth's oceans is probably due to the presence or absence of waves caused by the wind, though these are too small to be seen through even our most powerful telescopes. Water is unaltered by the passage of cloud over it; but land sometimes changes to a brilliant white which disappears later, sometimes causing temporary lakes. It is reasonable to suppose that clouds are a light form of water, that the white deposit is a frozen form, and that this melts to give lakes which are fed and drained by the channels we see. Many such channels have been accurately traced. Except where water reflects the sunlight, they are invisible, but can be mapped a few miles at a time as the Sun's position allows. For streams far from the Equator the Sun's position is not favourable.

'Earth's mountains—of which some are always white—are known to us by their shadows. In other places the colour of the land is permanently yellow or brown, grey or green; or it may change seasonally from green to brown or black. Very fine patchwork areas are supposed to show intelligent cultivation by creatures who are also responsible for numerous dark spots which have spread greatly during the past two centuries and which can now be seen to be faintly luminous at night. The nightly displays of minute cloud flashes are believed to be natural. The atmosphere of the Earth, which we see by its faint bluish colour in sunlight, extends twenty times as far as the highest clouds. Near the poles it glows mysteriously at night, especially when sunspots are active.'

See also Earth, History of; Mountain Building; Continental Drift; Tides; Astronomy; Calendar.

EARTH, HISTORY OF. There are several ways by which we can try to estimate the age of the Earth, but the most reliable 'clock' for this purpose is probably the radio-active element uranium, which slowly changes into lead. The rate of change is known, and so by comparing the proportions of lead and uranium in the Earth's crust to-day we can form a fair idea of when the rocks first solidified (*see* MINERALS, Section 2). This compares reasonably well with calculations based on the thickness of the known deposits of sedimentary ROCKS (q.v.).

It is believed that, about two or three thousand million years ago, the Earth, with the other PLANETS (q.v.), was hurled off the SUN (q.v.) into space. At that time it was as hot as the Sun, and molten and even gaseous. Before it had cooled enough to solidify, a similar happening caused the Earth itself to throw off about one-eightieth of its bulk, which formed the MOON (q.v.). Some scientists think that the gap then made in the earth is now the Pacific Ocean. As the molten globe cooled, its lighter constituents collected on the surface in a crust, like slag on the molten iron in a blast-furnace. When this crust finally solidified, it floated in irregular masses upon the heavier layer underneath. So the Earth's first crust consisted of a very thin crust of blackish lava, above which rose irregular solid masses, occupying about a quarter of the surface.

Round the red-hot spinning ball of the Earth there was at that time a blanket of gases, some of which had been torn away from the Sun's surface, and some of which had escaped later from the Earth itself. As the Earth's surface became cooler great quantities of steam, which had formed from the combining of hydrogen and oxygen, condensed into water—and this filled the more level parts of the crust's surface to make the first oceans and seas. From that time sun, wind, rain, and, perhaps, frost began the process of rock destruction which we know as DENUDATION (q.v.); and sediments began to accumulate in the shallow seas.

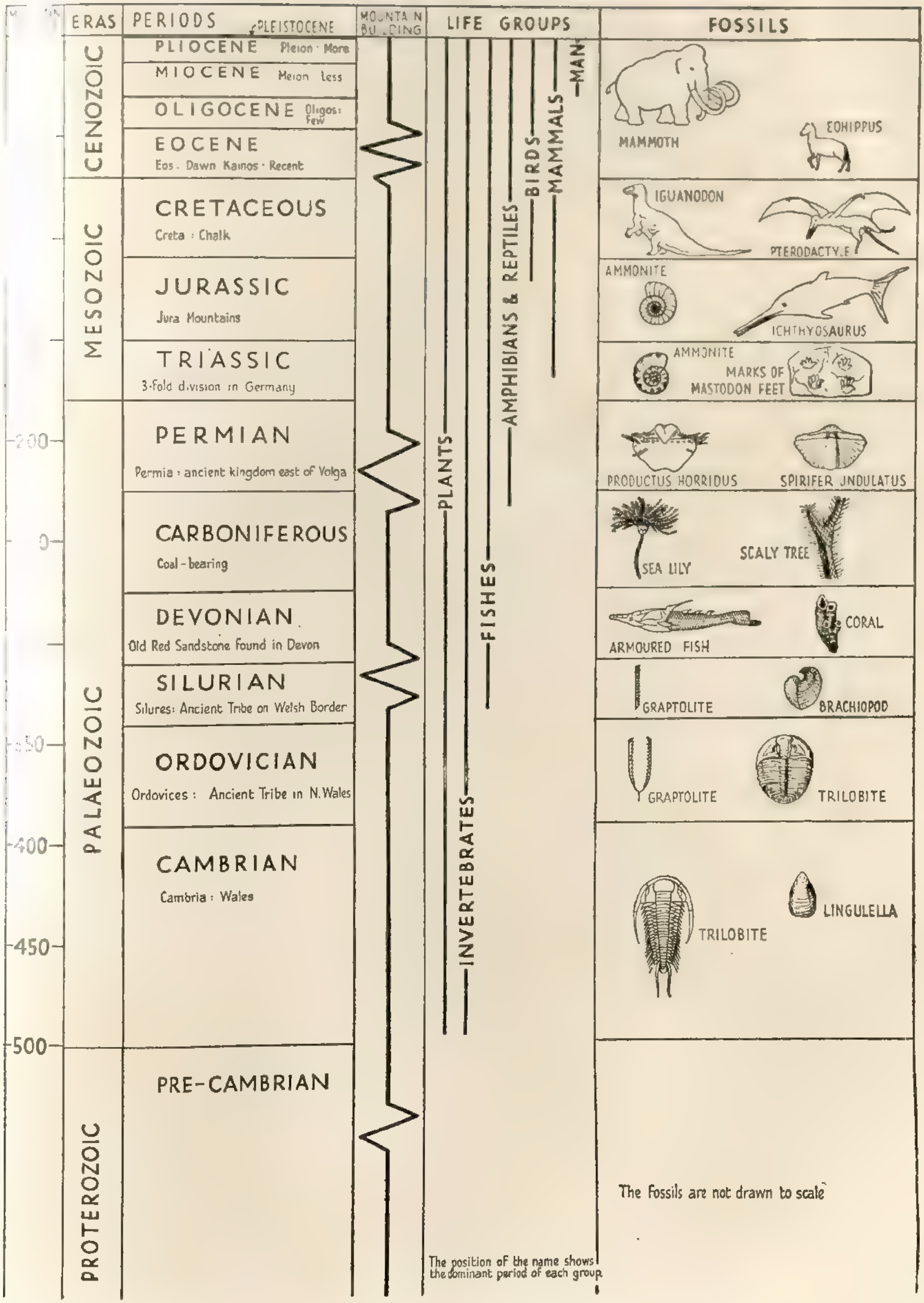
From the time that sediments began to form, the history of the Earth has consisted of a succession of interchange movements between the shallow seas and the adjoining land. During periods of scores of millions of years, the beds of the shallow seas sank continuously beneath the load of thousands of feet of sediment, while the adjoining land was pushed upwards.

Eventually some of the semi-plastic sub-crust poured out over the land surface, and simultaneously, or later, the bed of the shallow sea ceased to sink and began to rise instead, thrusting the sediments up above water. In some areas the margins of the land sank under shallow water. Sometimes these rhythmic movements of balance were on a relatively small scale and affected only a small proportion of the land surface; sometimes they were on a gigantic scale, involving a whole continent or more—and then they were the movements of MOUNTAIN BUILDING (q.v.), sometimes called 'revolutions', because they had such a profound effect upon the Earth's surface.

We have proof that at least nine great folding movements occurred; and as knowledge increases we may discover evidence for even more of these in the Pre-Cambrian rocks—in which six are already recorded (*see* Chart). These rocks are the oldest of all, and have been so changed by the pressure and heat to which they have been subjected that the unravelling of their story is exceedingly difficult (*see* ROCK FORMATION). Only the youngest of them contain any FOSSILS (q.v.) as evidence of former life, and even in these the remains are scanty. In the Cambrian sediments we find representatives of many of the principal groups of PREHISTORIC ANIMALS (q.v.), and it is clear that the forms we discover must have had a long history before them in order to have developed such complicated structures.

But the sediments which might have held the story of the earliest forms of life have been changed into other types of rock, and all traces of fossils have been obliterated (*see* ROCKS, Section 4). It is only in comparatively unchanged sediments that we are able to pursue the story of the Earth as told by the remains of animals and plants, for they are preserved only under certain conditions, generally involving swamp, or lake, or sea (*see* FOSSILS).

It must be remembered, however, that the land masses of the world may not always have been in the same relationship to each other: there is reason to believe, for example, that western Europe was once joined to Greenland and North America (*see* CONTINENTAL DRIFT). Another big problem which confronts us as we look back into the Earth's history is the cause of the changes in climate. During most of the time following the last Pre-Cambrian folding, the



ERAS
PERIODS
PLEISTOCENE
MOUNTAIN BUILDING
LIFE GROUPS
FOSSILS
CENOZOIC
PLIOCENE Pleion · More
MIOCENE Meion · less
OLIGOCENE Oligos: Few
EOCENE
Eos - Dawn Kainos - Recent
MESOZOIC
CRETACEOUS
Creta : Chalk
JURASSIC
Jura Mountains
TRIASSIC
3-Fold division in Germany
PALAEOZOIC
PERMIAN
Permia : ancient kingdom east of Volga
CARBONIFEROUS
Coal - bearing
DEVONIAN
Old Red Sandstone Found in Devon
SILURIAN
Silures: Ancient Tribe on Welsh Border
ORDOVICIAN
Ordovices : Ancient Tribe in N. Wales
CAMBRIAN
Cambria : Wales
PROTEROZOIC
PRE-CAMBRIAN
200
400
450
500
MAN
MAMMALS
BIRDS
AMPHIBIANS & REPTILES
PLANTS
FISHES
INVERTEBRATES
The position of the name shows the dominant period of each group.
MAMMOTH
EOHIPPUS
IGUANODON
PTERODACTYLE
AMMONITE
ICHTHYOSAURUS
AMMONITE
MARKS OF MASTODON FEET
PRODUCTUS HORRIDUS
SPIRIFER UNDULATUS
SEA LILY
SCALY TREE
ARMOURED FISH
CORAL
GRAPTOLITE
BRACHIOPOD
GRAPTOLITE
TRILOBITE
TRILOBITE
LINGULELLA
The Fossils are not drawn to scale

climate of the region in which the rocks of England were formed was tropical or sub-tropical. In the Quaternary (or Pleistocene) period, however, there came the ICE AGE (q.v.), which seems to have affected not only Europe but the whole world. Many suggestions have been put forward to explain the Ice Age; but none of them explains all the known facts. In Palaeozoic sediments in other parts of the world, too, there is evidence of extensive glacial conditions, associated perhaps with earlier Ice Ages.

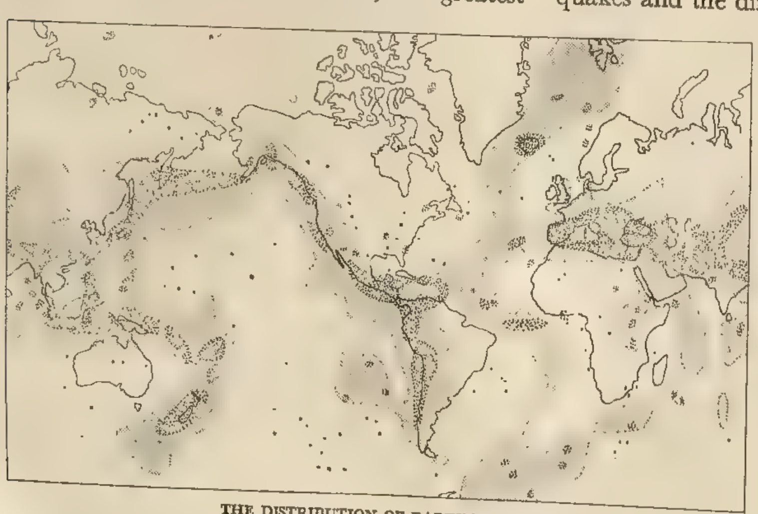
See also EARTH; CONTINENTAL DRIFT; DENUDATION; ROCKS; ROCK FORMATION; MOUNTAIN BUILDING.

EARTHQUAKES. Any shaking of the Earth's crust by natural forces is an earthquake. Shocks range in strength from very small ones which can be detected only by very sensitive instruments, to great earthquakes like the Assam earthquake of 1897, which devastated 150,000 square miles of north-eastern India and was felt throughout 4,200,000 square miles. In the devastated area all buildings, railways, and bridges were completely destroyed, great cracks opened on hills and plains, and waterlogged sands, forced up through the rock, spread like floods over the country-side. In some places the land rose to form cliffs up to 35 feet high, and in others sank so that lakes quickly formed in the hollows. Over 250 miles away in Calcutta many buildings were damaged, and the shock reached Europe in earthquake waves 35 miles long that gave the crust a rise and fall of 20 inches.

When earthquakes strike cities, the greatest damage is usually due to secondary effects such as the rupture of gas-mains, water-mains and electric cables. For instance, the disastrous Japanese earthquake of 1923 struck Tokyo when the midday meal was being prepared: consequently, many charcoal braziers were overturned, setting light to the flimsy Japanese houses, mainly built of paper and laths. Fires broke out all over the city, and as the water-mains were ruptured, the fire-brigade could do nothing. In the appalling fire that swept the city, nearly 150,000 people lost their lives and in the neighbouring city of Yokohama another 100,000 died. Of the £1,000,000,000 of damage caused in Tokyo, only £50,000,000 was attributed to the shock: the rest was caused by fire.

In an earthquake, buildings with steel or ferro-concrete frames suffer little damage because they are able to move up and down as one body. The ancient Greeks, in a country subject to earthquakes, used a similar principle when building their temples: they erected a comparatively light building on a massive platform of masonry set on swampy ground. Under earthquake strain, the platform rocked as a whole, like a pontoon, and the temple was not destroyed.

Modern investigation of earthquakes is made by instruments called 'seismographs' (Gk. *seismos*, earthquake, *graphein*, to write). Instruments for this purpose were invented in very early times. A Chinese named Choko, in A.D. 136, made an instrument which recorded earthquakes and the direction from which the shock came, thus giving the news several days before it could be received by messenger.



THE DISTRIBUTION OF EARTHQUAKES
Earthquakes occur most frequently in the areas with darker shading

One of the most successful seismographs is that invented by Professor Milne and Dr. J. J. Shaw in the early years of this century. It is more properly called a seismometer because, besides drawing a record of the shock, it gives a measure of its intensity.

A seismograph record shows that earthquake shocks are transmitted in three series of waves. The first to arrive are the primary, P, or 'push and pull'

DAMAGE CAUSED BY THE EARTHQUAKE AT QUETTA IN 1935
Sir Clarmont P. Skrine

ves, which begin at a speed of about 5 les per second and reach as much as 8 miles r second, the speed varying with depth of netration. These waves, like the next to rive, the secondary, S, or 'shake' waves, travel rough the interior of the Earth. S waves, which are at right angles to the path of the P waves, vary in speed from 2·5 to 4·5 miles per second. The last waves to arrive are known as the 'long', L, or 'maximum' waves, because they show the greatest disturbance in the seismograph. These waves travel round the Earth's surface, at a speed of about 2·5 miles per second.

It is lucky that the different types of wave travel at different speeds, because from the differences in time of their arrival we can estimate the distance they have travelled. This leads to an important result: with the data from three, or preferably more, stations it is possible to draw on a globe circles with radii equal to the distances of the seismographs from the earthquake centre—the point where these circles cut being the centre of the disturbance. This point is more correctly known as the 'epicentre' (Gk. *epi*, outside)—because the true centre of the earthquake must lie beneath the crust. In minor earthquakes the centre probably lies only a few miles down; but great earthquakes may originate perhaps as much as 100 miles below the surface.

The records of seismographs are our chief source of information about the interior of the EARTH (q.v.). The speed at which earthquake waves travel when they are at a greater depth than about 6¼ miles shows that between this level and a lower basalt layer, the rock must be very like granite. Waves going deeper than the basalt layer show that the central core of the Earth must be of very different nature from the outer layers, because this central region does not transmit the S waves at all, and so must either be liquid or gas under a pressure quite beyond our experience. Only the P waves travel through the centre of the Earth, and they appear to be bent as they enter and leave the core.

CAUSES OF EARTHQUAKES. Many of the smaller and more localized earthquakes are associated with VOLCANOES (q.v.), though it is very unusual for volcanoes to cause such great shocks as occurred at the explosion of KRAKATAU (q.v.). Other small earthquakes are caused by slight shifting of 'strata' or beds of rock at a weak

place or 'fault'. Severe earthquakes may either occur along important lines of faulting, such as the Rift Valley of East Africa, or arise from several scores of miles below the surface.

The map showing the distribution of the epicentres of recent earthquakes makes it plain that earthquakes occur mainly in regions of folding associated with great mountain chains. The modern theory of MOUNTAIN BUILDING (q.v.) helps us to understand why this should be so. In some cases it may be that the process of uplift which follows mountain building is still incomplete. If this is so, it is little wonder that in such regions disastrous earthquakes occur from time to time. Nor need we be surprised that the Earth is shaken by at least one powerful earthquake every day. It is fortunate that many of them affect areas far from great cities or take place beneath the sea. Not all submarine earthquakes are harmless, however, for the movement of the sea-bed may cause a tidal wave and bring about great loss of life, as at Lisbon in 1755. A study of earthquakes makes it clear that the crust is in a state of constant vibration—so that Shakespeare was more poetic than accurate when he wrote 'thou sure and firm set earth'.

See also EARTH; MOUNTAIN BUILDING; ROCK FORMATION.

EAST AFRICA. Northwards from the Union of South Africa, along the east coast of the continent, lie Portuguese East Africa (Mozambique), Tanganyika, and Kenya; with Nyasaland in the south and Uganda in the north, inland of them (*see* Map, p. 5). The whole region, bounded in the north by Somaliland, is known as East Africa. Lying well within the tropics, it contains few white people, but has a large native or Bantu Negro population.

East Africa, like the Union of South Africa, consists of a fairly level coastal plain, varying in width from 50 to 300 miles, backed by a series of terraces rising abruptly to the plateau or 'high veld', more than 4,000 feet above sea-level. The harbour towns—Beira and Lourenço Marques in Portuguese East Africa, Dar-es-Salaam in Tanganyika, and Mombasa in Kenya—have very similar climates and vegetation, although the nearer they are to the Equator, the wetter and warmer they are. There is almost no winter; there are rains almost all the year round; temperatures are high; vegetation is abundant; and typical hot-country crops are grown. The top of the plateau is very different. Though it is never really cold so near the Equator, except at heights of 7,000 or 8,000 feet, the nights are cooler; the rainfall is less; and instead of the thick forests and swamps of the coastal area, there are grasslands with plenty of trees and broad areas of such cereals as maize. This 'high veld' is very thinly populated by Europeans, and there is still plenty of game on it (*see* GRASSLANDS, Section 3).

The plateau is cut by the great Rift Valley in which lie the long narrow lakes of Tanganyika and Nyasa. These, like the great Lake Victoria, 200 miles long, are used for transport.

Portuguese East Africa, or Mozambique, has been a Portuguese colony for hundreds of years; but as by far the greater part of it is low, swampy plain, there has been almost no colonization and only about 10,000 Europeans live there. The chief importance of the colony lies in its two big ports: Lourenço Marques (or Delagoa Bay), through which pass great quantities of goods bound for the Witwatersrand and the rest of the Transvaal, and Beira, which is the port for Salisbury in Southern Rhodesia, and for Nyasaland.

Tanganyika was proclaimed German territory in 1886, and remained so till 1918, when it became a British Mandate. Its chief port is Dar-es-Salaam, from which a railway runs inland to Lake Tanganyika. Its area is 360,000 square miles—about seven times as big as England, but its population is only about $7\frac{3}{4}$ millions, of whom about 18,000 are Europeans. These are mostly either government officials or farmers, and almost all live on the plateau. The chief crops are sisal, cotton, and coffee. Mt. Kilimanjaro (19,565 feet), the highest peak in Africa, is in Tanganyika. Although it lies almost on the Equator, it is snow-capped throughout the year.

Off Tanganyika, but quite independent, there is the small island protectorate of ZANZIBAR (q.v.), which produces almost all the world's supply of cloves. It has a good harbour.

Kenya is not quite as big as Tanganyika. It is a British colony, and its population of over five millions includes 30,000 Europeans and 55,000 Indians. The European population is growing; but the greater part of the country is reserved for natives. The principal towns are Nairobi, the capital on the plateau, and Mombasa, a busy port. The two are linked by rail. The chief products are wheat, sisal, and coffee. Kenya also produces the bulk of the world's

TANGANYIKA, EAST AFRICA *Royal Geographical Society*

supplies of pyrethrum seed, which is much used in the preparation of insecticides.

UGANDA (q.v.) lies inland from Kenya. It is a protectorate and not a colony, and very little European colonization is possible. Its 3,000 Europeans are almost all officials. The chief occupation of the five million natives is cotton-growing.

Nyasaland, also a protectorate, is a long narrow strip of country lying to the west of Lake Nyasa. It has two million natives and about 4,000 Europeans, most of whom live on the Shire Highlands. They grow cotton, tobacco, tea, and rubber. The chief towns are Zomba, the capital, and Blantyre, which is linked by rail with Beira. The lower areas near the lake are very unhealthy, sleeping sickness, blackwater fever, and malaria being common.

See also AFRICA.
See also Vol. I: NEGRO AFRICANS; MASAI.

EASTER ISLAND, *see* Map, p. 323; *see* Vol. I: POLYNESIANS.

EAST INDIES. These are the islands which lie between south-east Asia and north Australia. They are known also as Malaysia, the Malay Archipelago, and Indonesia.

There are over 2,000 islands in the East Indies. Some of them are only barren rocks covered by the sea at high tide. Others, such as New Guinea, Borneo, and Sumatra, are very large. New Guinea is the second largest island in the world. Borneo is the third largest and is almost the same size as France. The east to west length of the East Indies is greater than that of Europe, and from north to south they stretch as far as from Edinburgh to Madrid.

All the islands lie between the Tropic of Cancer and the Tropic of Capricorn, Sumatra and Borneo being right on the Equator. And so the climate of the East Indies is everywhere very similar—unlike the climate of Europe, which is very different in the north from what it is in the south. Temperatures are high, and there is much rain, generally in the form of heavy thunder-storms.

The islands are unlike Europe in many other ways. Though there are sandy and pebbly

beaches, rocky shores and cliffs such as we find in Britain, there are also mangrove coasts, coral coasts, and beaches of volcanic material. But the rocky shores differ from British rocky shores in having very little or no seaweed—because the warm sea cannot hold enough air to support

THE EAST INDIES

much plant life. It is almost impossible to land on a mangrove coast because of the deep mud and the twisted tangled roots of the trees. Coral may make a rough beach, difficult to walk on because of its hard, sharp, uneven surface, or it may be in the form of a barrier reef separated from the shore by a strip of water so clear that objects on the sea bottom can be seen even at depths of 30 feet (*see* CORAL ISLANDS). Beaches formed of volcanic material are usually dark in colour, and are often quite black, as on parts of the south coast of Java (*see* COASTS).

Mountains and hills occupy a very large part of the East Indies, Sumatra being the only island with a big area of lowland—mostly swampy jungle. There are high, steep-sided mountain ranges and hilly plateaux, and more than seventy active VOLCANOES (q.v.). Unlike the volcanoes of Europe, these seldom pour forth lava. Rivers of boiling mud, or of hot water and ashes, are more usual, while steam and burning gases escape through cracks and vents in the mountain sides. The tremendous eruption of KRAKATAU (q.v.) between Sumatra and Java occurred in 1883.

The greater part of the islands, especially of Borneo, Sumatra, and New Guinea, is covered by dense forests. Their many different trees and shrubs, mainly evergreens, grow quickly and luxuriantly because of the high temperature and the abundance of rain. There are rhododendrons and ferns, and orchids only to be found in hot-houses in this country; there are tropical plants with pale green flowers, with flowers of huge size, up to a yard across, and with thick fleshy leaves. Then there are strangely shaped plants which catch and eat insects (*see* INSECTIVOROUS PLANTS, Vol. II).

The forests hold many wild animals. In the western islands, such as Sumatra, Java, and Borneo, the animals are like those found in India and Burma, including elephants, wild pigs, monkeys, tigers, leopards, rhinoceroses, deer, antelopes, and crocodiles, and also many snakes and pythons. But in the eastern islands the animals are like those found in Australia, and include bats, flying opossums, kangaroos (in New Guinea and the Moluccas), and wallabies. There are birds of many kinds, including parrots and birds of paradise with jewel-like plumage—and everywhere are gaudy butterflies.

Parts of the forests have been cut by the island

By courtesy of the Victoria and Albert Museum

A NATIVE BOAT AT SANDAKAN, BORNEO
Water-colour by R. T. Pritchett (1828–1907)

RICE-FIELDS IN BALI

peoples to make room for food crops, and on some islands large areas have been cleared for estates and plantations supervised by Europeans.

Of all the islands, Java and Bali are the most densely peopled and the most developed. Both have high, steep mountains (Java has seventeen big volcanoes) and their sides have been terraced into small fields watered by cunningly arranged channels. The flat marshy plains along the coast have been drained just as cleverly. The Dutch, who are the principal white settlers, have given much help in this work by constructing huge canals, with dams and weirs to regulate the flow of water. The chief crop in the terraced mountain fields and in the plains is rice. A curious crop in Java is fish! Villagers in many parts of the island have fish-ponds in which small fish are reared for food.

In the Middle Ages and up to the 18th century, the East Indies, and especially the Moluccas, were famous for their export of spices—indeed they were known as the spice islands. But now, rubber, sugar, tea, coffee, palm-oil, tobacco, and quinine (from the bark of the cinchona tree) are very much more important. A great proportion of these are grown on estates and plantations supervised by Europeans—mostly on Java and Sumatra. Oil from Sumatra, Celebes, and Java, tin from islands off the east coast of Sumatra, and coal, bauxite (ore yielding aluminium), gold, silver, sulphur, and kaolin (china clay) are also important exports. In Java and Madura, salt is prepared from sea-water by evaporation.

In 1945, Java, Sumatra, Celebes, the Molucca Islands, the lesser Sunda Islands, and part of Borneo became the Republic of Indonesia. Djakarta, the capital, formerly called Batavia, has a population of over 2,000,000. The towns all grew up through European trading and settlement. They are either ports or are situated in the hills where the climate is cooler.

See also Singapore.
See also Vol. I: Indonesians.

ECHO, *see* Sound.

ECLIPSE. We say that one of the heavenly bodies is eclipsed when its light is cut off as a result of some other body getting between it and

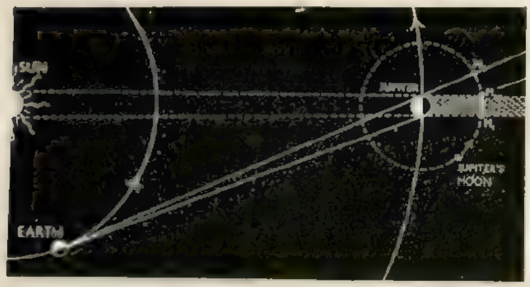


FIG. 1. ECLIPSES AND OCCULTATIONS OF JUPITER'S MOONS

the Sun. An 'occultation', on the other hand, takes place when a body is hidden from view behind another. In Fig. 1, a moon of Jupiter would be eclipsed between M_1 and M_2 but occulted between M_2 and M_3.

Eclipses may be of three kinds: (*a*) 'total', (*b*) 'partial', or (*c*) 'annular' (or ring-shaped). Fig. 2 shows the kind of shadow cast into space by a body such as the Earth or the Moon. It consists of two parts: the 'umbra' or complete shadow (marked black in the diagram), and the 'penumbra' or partial shadow (shaded in the diagram). An observer in the 'umbra' sees a total eclipse, because the Sun is entirely hidden from him; but if he is in the penumbra, the eclipse is partial, since a crescent-shaped part of the Sun will always remain in sight. If, however, he is in the part marked with vertical lines in the diagram, he will see an annular eclipse.

ECLIPSE OF THE MOON. If in Fig. 2 we take X to be the Earth, then as the Moon circles

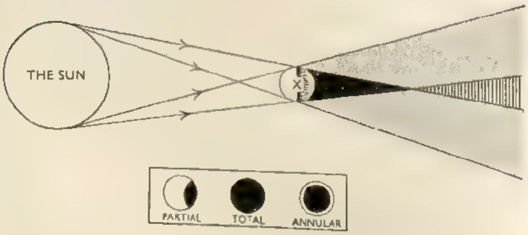


FIG. 2. ECLIPSES

round us, it will occasionally pass through the umbra or penumbra, and so be either totally or partially eclipsed. It might be thought that an eclipse of the Moon should happen every month, the period it takes to move round the Earth; but the Moon usually passes above or below the Earth's shadow, because the path it follows is at a slight angle (about 5 degrees) to the 'ecliptic'—or the path of the Earth round the Sun (see Fig. 3). A total eclipse of the Moon may last as long as 3 hours. The crescent-shaped view of the Moon that might be expected in a partial eclipse must not be confused with the crescent shapes seen in the Moon's 'phases'. It is not difficult to see that eclipses of the Moon can take place only when the Moon is full—that is to say, when the Sun is shining full on the face turned towards the Earth—and during a small partial eclipse little more than a slight dimming of the light is noticeable. Even at 'totality', when its light might be expected to be blotted right out, the Moon can still be seen shining with a dim copper-coloured glow. This is because the Earth's atmosphere bends or 'refracts' the Sun's light, so that there is a little stray light in the umbra after all (*see* WAVE MOTION, Section 3).

ECLIPSE OF THE SUN. If X in Fig. 2 is the Moon, then the distances are such that the Earth sometimes just touches the part marked black, at other times is just beyond it, causing either a total or an annular eclipse of the Sun. As the umbra or shadow of the Moon on the Earth is at best not much more than 100 miles wide, it is not often that it passes across England. Many readers will probably never have seen, or have the chance to see, a total eclipse—and even when the chance arrives it may be cloudy during the brief few minutes of the eclipse. The last occasion in England was on 29 June 1927, and the next will be on 11 August 1999. A solar eclipse is an awe-inspiring spectacle, and the feeling of apprehension is heightened by the way in which, as the light fades to an unnatural dusk, all bird song ceases.

There are always two eclipses of the Sun to be seen somewhere in the world each year. There may be as many as seven eclipses of the Sun and Moon (either five solar and two lunar, or four solar and three lunar). But when the path of the Sun's total eclipse falls across the sea or over uninhabitable land, astronomers are usually unable to take proper advantage of the occasion. A total eclipse of the Sun is an event important enough to justify expensive expeditions. It gives a chance of finding out whether there is an undiscovered planet nearer to the Sun than Mercury. The Sun's outer layers—the 'chromosphere', the 'corona', and the 'prominences'

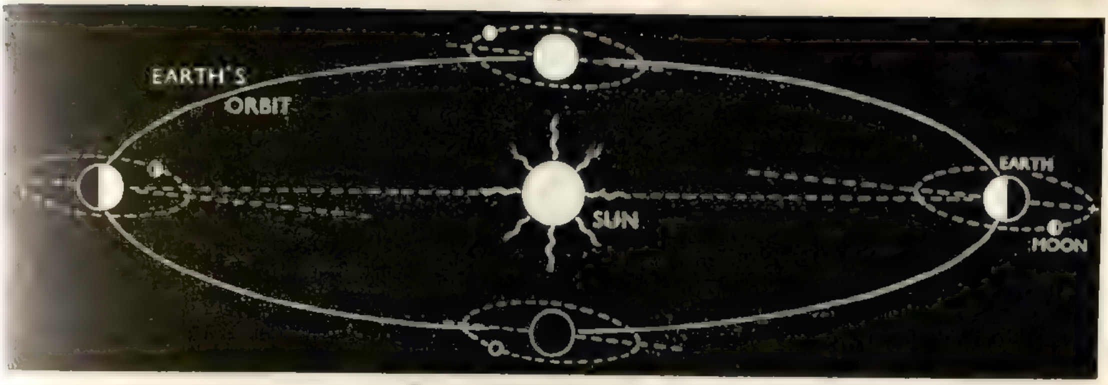


FIG. 3. THE ORBIT OF THE MOON

s the Moon's orbit is not in the same plane as the Earth's, it is not eclipsed every month when the earth is between it and the Sun

e SUN)—can also be studied. Perhaps the most citing observations ever made during an lipse were in May 1919, when photographs of rs near the eclipsed Sun showed them to be ghtly out of their normal positions—out by actly the amount Einstein had predicted by ans of his Theory of RELATIVITY (q.v.). The ts were checked again in 1922. This is one the observational proofs of the Theory of lativity.

ECLIPSES OF JUPITER'S MOONS. Jupiter has ven moons (*see* PLANETS), and for two reasons eir eclipses are of particular interest. Firstly, vigators can tell the time by them at night, ing the necessary tables, and can thus use them a rough means of finding longitude. The troduction of modern instruments makes these d methods no longer necessary. Secondly, it as by observations on their times that a Danish stronomer, Roemer, was able, in 1675, to neasure the speed of LIGHT (q.v.). It is very interesting to watch Jupiter's moons, because their system is very like a miniature solar system, except that the light comes from the Sun outside the system instead of from the central body itself. As a result of this we get both eclipses and occultations of Jupiter's moons. These occur at regular intervals—apparent irregularities in the times of these eclipses were shown by Roemer to be due not to the irregular motion of Jupiter's moons, but to the finite speed of light and to the varying distance of the Earth from Jupiter.

See also ASTRONOMY, MODERN; ASTRONOMY, HISTORY OF; SUN; MOON; PLANETS.

ECUADOR. Though one of the smallest of the South American states (*see* Map, p. 415), Ecuador has within its boundaries tropical forest, mangrove swamps, rich fertile plains, poor steppe lands, and high mountain peaks. Behind the mangrove swamps and sandy beaches of its Pacific coast is a rich tropical plain, irrigated and drained by several meandering rivers. Guayaquil, the chief port and the largest city, is situated on the Guayas, the most important of these rivers, about 30 miles from the sea. Cocoa is Ecuador's chief product, others being coffee, bananas, rice, cotton, and tobacco. Palms flourish on the sandy, salty soil near the sea, and from the fibre of one type, the toquilla palm, the Indian women make the famous Ecuador 'Panama' hats.

The great western and eastern ranges of the Andes and the mighty depression between them form a very different region of Ecuador. The highest peak in the Western Range rises to a height of over 20,500 feet. The mountain Pichincha, 16,000 feet high, is renowned for its intense volcanic activity, while in the Eastern Range the mountain Cotopaxi, 19,400 feet high, is the highest active volcano in the world. In the high valleys between these mountains live most of the people of Ecuador, of whom there are over three millions. These valleys are so high that although they are practically on the Equator, they have a climate which is like perpetual spring. Their yellow and green fields, avenues of eucalyptus trees, and red-tiled towns are very beautiful against the background of high-peaked snow-capped mountains. The Indians, wrapped in brightly coloured *ponchos*, or blankets, drive their llamas down from the country-side to the markets, bringing ice from the mountains as well as other country produce.

A VILLAGE IN ECUADOR
American Geographical Society

Sheep and cattle rearing are important occupations. The ancient city of Quitó, the capital of Ecuador, is situated in one of these high Andean valleys, at about 9,000 feet. Originally an Indian city, Quito became a great centre of art and culture under Spanish rule.

The lower Pacific slopes of the Andes are heavily forested, and in these forests grows the cinchona, from which quinine is extracted—a very important drug in a tropical country. On the lower slopes great mahogany trees flourish. East of the Andes the land is mainly hot, wet, tropical forest, part of the Amazon basin, which is little explored and sparsely inhabited. It is crossed by many rivers draining southwards to the AMAZON (q.v.), most of which are navigable by small steamers.

The Galapagos Islands, about 600 miles out in the Pacific, belong to Ecuador. 'Galapagos' is the Spanish word for tortoises, and these islands were first known for the giant tortoises found there, and because they were the haunts of pirates. Now they have a population of some 2,500 people, and are important as being an outpost of the Panama Canal. During the Second World War American troops were stationed there for its protection.

See also SOUTH AMERICA.
See also Vol. I: ECUADOR, PEOPLE OF.

EDINBURGH. The capital of Scotland is built on the southern shore of the estuary of the River Forth, where a steep basalt ridge breaks the level of the coastal plain. The site was originally chosen with an eye to defence rather than convenience, for the first building erected, and on the highest point, was a castle. This was the centre of Scottish Government until the Union of the Crowns in 1603.

The deep valley surrounding the Castle Rock was marshy. The result was that the old town of Edinburgh could grow only along the narrow ridge-top in the form of a single street of tall steep-roofed medieval houses—often twelve storeys high. This street is the famous Royal Mile, which has so many associations with Scottish history.

By the middle of the 18th century Scotland had emerged from a long period of internal strife, and with prosperity came a desire to expand the

ity of Edinburgh. In 1772 bridges were com-
pleted across the marshy valleys to the north and outh of the Royal Mile, connecting the town with new building land. The New Town, planned by Craig, Sibbald, Reid and Robert ADAM (q.v. Vol. V), grew quickly in broad treets and squares whose classic orderliness is n complete contrast to the castle and rugged alls of the old town. The marshy valley to the orth of the Castle ridge was drained and laid ut in gardens, which form one side of Princes Street, a street world-famous for its beauty. On he other side are Edinburgh's principal shops.

It was during this period of expansion that dinburgh built up her cultural reputation. In iterature, philosophy, painting, and archi- ecture, she produced such men as Sir Walter cott, Allan Ramsay, Dugald Stewart, David Iume, Raeburn, and the brothers Adam. The adition of culture lives on to the present day nd, together with the solid grandeur of its site nd buildings, makes Edinburgh a natural apital.

The government departments concerned with cottish affairs and the supreme Court of Scot- and are housed in the city. The Palace of Iolyroodhouse is used by the Royal Family luring their visits to Edinburgh. Once every ear the General Assembly of the Church of cotland meets in Edinburgh. There are a large umber of schools and colleges, and the Medical School of the University has a world-wide reputation.

EDINBURGH, SHOWING THE CASTLE AND PRINCES STREET
The Times

Although Edinburgh has been eclipsed as an industrial city by GLASGOW (q.v.), it still has a number of varied industries. The most important are brewing, paper-making, book-printing and publishing, and the manufacture of rubber. A small but vital industry is map-making.

The port of Edinburgh is Leith, from where trade is carried on with Baltic and European ports. Many coastal trading-ships call there to load coal from the Midlothian coal-field. Newhaven and Musselburgh, formerly fishing villages, but now suburbs of Edinburgh, are engaged in the North Sea fishing industry.

The population of Edinburgh and Leith is about 466,700.

See also SCOTLAND.

EGYPT. The home of one of the most ancient civilizations in the world—the land of the lower stretches of the River Nile—lies in the north-east corner of Africa (*see* Map, p. 5). It is over four times the size of Great Britain; but, as most of it is desert or semi-desert, only about one twenty-fifth of its area is cultivated. The long, narrow, intensively cultivated and thickly populated strip of the Nile valley is surrounded by desert. Western Egypt is part of the Libyan Desert, and to the south lie the wastes of the SUDAN (q.v.). To the east is the Arabian Desert, continuing on the other side of the Red Sea in Arabia. To the north-east, across the SUEZ CANAL (q.v. Vol. IV) and the Gulf of Suez, lies the peninsula of Sinai, a desert land which rises to mountainous ranges in the south. Its highest peak is Mt. Sinai, over 8,000 feet high, where, according to the Hebrew Story, Moses received the Ten Commandments from God. Apart from this mountain range, which continues down the east coast of the Gulf of Suez and beyond, with occasional peaks rising over 6,000 feet, Egypt is remarkable for its extreme flatness. The summer temperature is high, and there is little rainfall.

The desert and semi-desert lands are on a gently sloping plateau from 600 to 1,800 feet in height, broken by scattered single hills and occasional depressions (such as the salt-marsh depression of Qattara in the north-west). In some regions the desert is composed of shifting dunes of loose sand, and in others of pebbles and

AN EGYPTIAN VILLAGE NEAR THE GREAT PYRAMID

H. D. Keilor

bare earth. Owing to lack of water, cultivation is restricted to the few oases. These depend on underground water-supplies for the growing of date-palms—dates being the staple diet of the inhabitants. A few oases are large enough to support permanent towns, such as Siwa on the borders of Libya, and to allow for the cultivation of a variety of crops; but the majority are small and make settlements for the wandering Bedouin (q.v. Vol. I), the people of the desert. The camels of the Bedouin can find enough food by wandering from place to place in search of coarse pasture and scrub (*see* Deserts).

The wealth and prosperity of Egypt depend almost entirely, and have depended for thousands of years, on the Nile (q.v.). Its palm-lined banks are bordered by a belt of fields intensively worked by the peasants. The cultivated region varies in depth between a few hundred yards and as much as 10 miles. Crops include wheat, barley, maize, rice, lentils, beans, and clover. Cotton, indigo, sugar-cane, and tobacco are also grown. The ancient Egyptians relied upon the yearly flooding of the river to provide water and to enrich the soil by natural fertilizer in the form of silt. Now, the water of the Nile is controlled by dams, the best known of which is that at Aswan. Water is stored in these during the flood season, and is let out during the dry periods. From the river, the water is led by modern canals which split up into hundreds of small irrigation ditches. All along the river, however, the peasants can still be seen drawing up water from the river, as they have done for centuries, by primitive native pumps, called *Shadufs.*

Thousands of Egyptians rely for their living on the cotton crop. Although Egypt is not the largest cotton-exporting country in the world, it produces the finest cotton. Most of it is grown on the fan-shaped fertile Nile delta, which has been built up during centuries by silt brought down by the river in flood. Everything possible is being done to increase the amount of water available for irrigation, for the cotton cannot be

grown without it, and the time may come when ll the Nile waters will be used up before they each the Mediterranean.

Cairo (q.v.), the capital of Egypt, is at the ead of the delta, and is a large cosmopolitan mmercial city of some 2,100,000 people. lexandria, the chief port, and for long an nportant base of the British Mediterranean et, stands at the mouth of one of the western ranches of the Nile. Port Said is the port for the uez Canal, which runs just over 100 miles to uez at the head of the Gulf of Suez. The canal, lthough in Egyptian territory, is not in Egyptian control, but is controlled by the Suez Canal ompany. Up the river stands the lovely town f Luxor, with the ruins of the magnificent arnak temple of the ancient Egyptians nearby.

See also Vol. I: Egyptian Civilization; Egyptians; abs.

IRE, *see* Ireland.

LECTRICITY IN NATURE. The word ctricity is derived from the Greek *elektron*, eaning amber, and it is strange to think that many centuries not much more was known out electricity than that if amber was rubbed, attracted to itself bits of paper or other light jects. To-day almost all we understand with y certainty about the real nature of the tiny articles making up the atoms of which every rm of matter in the entire universe is composed, that they are charged with electricity and may, indeed, consist of electricity (*see* Matter). Furthermore, all forms of action in the universe, other than those of matter acting upon matter, are due to Radiation (q.v.), which, again, is purely electro-magnetic in character. No movement can take place without some disturbance of electric balance: all chemical actions, the nervous impulses in our bodies, even the thoughts in our brains, are accompanied by electrical changes. Electricity, then, is everywhere throughout existence, and may itself constitute all matter and energy. Here, however, we shall go no farther than to describe some of its more obvious manifestations in the natural world.

If a piece of amber is rubbed with flannel, the friction produces two kinds of electricity. We know there must be two kinds, because they behave in different ways: two pieces of amber, so electrified, repel each other, and so do two pieces of flannel; but a piece of amber and a piece of flannel attract each other and try to stick together. The same thing happens if glass is rubbed with silk. But if we now bring these near the amber and flannel, we find that glass attracts amber and repels flannel, but that silk does just the opposite, repelling amber and attracting flannel. It seems, then, that there is one kind of electricity in amber and silk, and another kind in glass and flannel. The first kind is called 'negative', the second 'positive'; and we say of them that similar charges repel, but dissimilar charges attract each other.

One of the main reasons why the existence of electricity in nature went unrecognized for so long was because electrical charges can generally leak away through a 'conductor' of some sort, and disappear unnoticed. The earth's surface, for instance, is a conductor; so is water or water-vapour (but not ice); so, too, are metals and many other substances. But as amber, glass, silk, and flannel are 'non-conductors', if an electric charge is produced in them, it cannot easily escape to earth—and so we have a good chance of noticing its presence. Dry air is a non-conductor, except in so far as it may have been ionized (as by Cosmic Rays (q.v.) for instance); but in our own climate the air is hardly ever dry enough to make it entirely non-conducting.

The explanation of how a body becomes electrified depends on a knowledge of the Atom (q.v.). Each atom has a number of electrons moving round a nucleus. The electrons are negative in charge (i.e. similar in charge to that carried by a rubbed piece of amber or silk), and the nucleus is positive, the size of the charges balancing perfectly. If energy is applied in such a way that one or more of the electrons is removed, the nuclear charge is no longer balanced by the electrons: there is an excess of positive charge over negative; so the atom is positively charged. If, however, the energy supplies extra electrons, then there is an excess of negative over positive, and the atom is negatively charged. The process of electrification is therefore one of creating electronic unbalance, and the force resulting from it acts towards correcting the unbalance. Electrically charged atoms or groups of atoms are called 'ions', the process of their formation being known as 'ionization'.

Just as a magnet is surrounded by a field of force, or 'magnetic field', within which it exercises its attraction, so there exists in the neighbourhood of a body carrying an electric charge

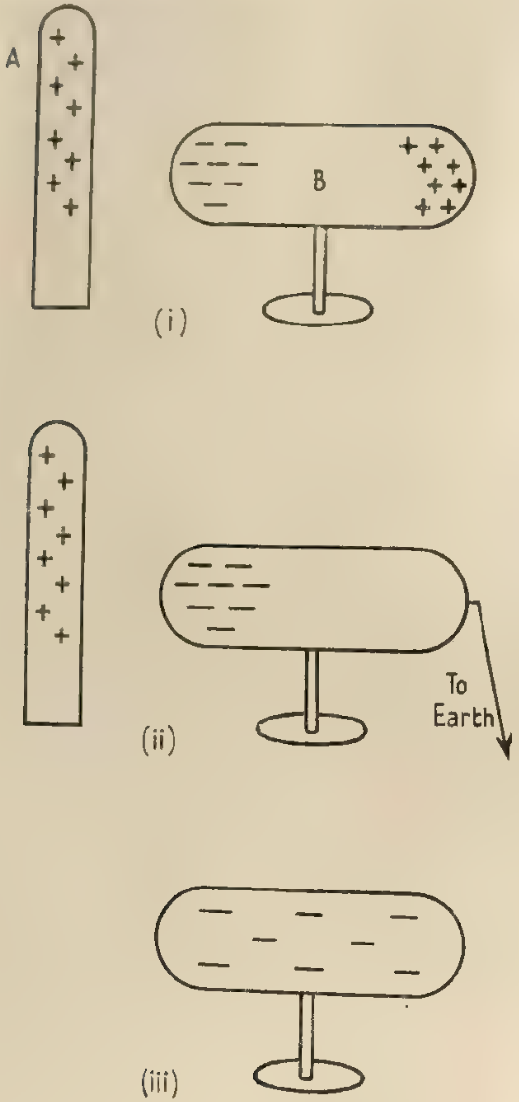


FIG. 1. BUILDING AN ELECTRIC CHARGE

a similar field of force called an 'electric field'. If a body made of some conducting material is brought into this field, so long as it is 'insulated' (i.e. separated from the earth by a non-conducting substance), it will itself receive an electric charge by what is known as 'induction'. Fig. 1 (i) shows the effect of bringing such a body, B, near a positively charged body, A. The field of force of A upsets the atoms of B so that electric unbalance is created, some atoms being negatively charged and an equal number positively charged. The fact that B is a conductor means that electrons are free to move across it, and (by the rule that dissimilar charges attract, while similar charges repel) they do this in the way shown. If the charge on A were negative, the effect on B would be reversed. One of the favourite experiments made by early investigators into electricity was the building up of such a big charge in B that when it was finally 'earthed' an electric spark would result. This they could do by the following process. First of all, the positive charge on B was earthed (*see* Fig. 1 (ii)) while the negative charge remained, held by the attraction of A's positive charge. A was then removed, causing the negative charge (i.e. the excess electrons) to spread over B (Fig. 1 (iii)). This operation could be repeated many times (for the charge on A is not reduced, except by stray losses) until the induced charge on B was as large as required. The similarity between lightning and an electric spark produced in this way was noticed early in the 18th century, and in 1752 Benjamin Franklin proved beyond doubt that lightning was due to electricity, by flying a kite in a thunder-storm. As the rain-wetted string made a conductor, he produced a spark and also felt a slight electric shock.

There is still some uncertainty as to precisely how the electric charges in a thunder-storm are built up. Three processes taking place in a thunder-cloud are known to be capable of causing electrification: friction between the ice particles found at the heights to which the upper parts of such clouds reach; the breaking up of large raindrops by fierce wind-currents; and the presence of ions in the atmosphere. But all three together are not considered sufficient explanation for the immense charges built up in a violent thunder-storm—which may well have several times the generating capacity of the world's largest power station. Still less do they explain the fact that the drops of rain in even a light shower, when there is no thunder about, are invariably found to be positively charged. In a THUNDER-STORM (q.v.) the falling rain is similarly charged; the cloud particles, especially in the upper part of the cloud, are usually, but not always, negative; and the flash itself almost always starts out from a positive to a negative region. Even when there is no actual flash, the high potential charges in the air may induce opposite charges in a tall earthed conductor, and if this has points on it, the electricity may discharge into the air so violently that light is seen in the form of a bluish glow spreading from the

nts. This phenomenon used to be called 'St. no's Fire', and, seen at the mastheads and the s of spars, has been familiar to sailors for idreds of years. Mountaineers on top of a peak have occasionally been terrified by milar occurrence, when they have noticed a w round the steel heads of their ice-axes, ompanied, so it is said, by a peculiar high ing note.

nother spectacular display of electricity in e natural world—though it is seen only rarely far south as the British Isles—is the AURORA REALIS (q.v.), or its southern counterpart the ora australis. The occasions when this enomenon is visible in regions far from the s, such as the British Isles, are always periods ntense sun-spot activity (*see* SUN). This sug-s an electro-magnetic cause for the aurora. principle appears to be similar to that ployed in gaseous discharge tubes—familiar us in the form of 'neon-lights' outside shops d cinemas—in which the passage of an electric arge (that is, of a stream of electrons) causes enclosed gas to glow. In fact, with suitable es, a very good imitation of auroral light can given.

It is known that when sun-spots are active, ctrically charged particles are thrown clear of e sun's gravitational pull by the increased ht-pressure caused by the gigantic eruptions its surface. Analysis of the spectrum of the urora (*see* COLOUR) shows that its light is due ainly to nitrogen and oxygen, the two elements of which air is composed: and so it seems reasonable to assume that these gases are made to glow by a stream of particles reaching the earth's outer atmosphere from the sun. The height from the earth's surface to the underside of the auroral arch varies between 50 and 200 miles; the entire phenomenon must therefore cover an enormous expanse of the atmosphere.

ELECTRON, *see* ATOM.

ELEMENT, *see* MATTER.

EMERALD. This has been for some time the most costly of all gem stones. It is the beautiful green variety of beryl, a silicate of aluminium and beryllium. AQUAMARINE (q.v.), golden beryl, and the pink morganite are also varieties of beryl.

One reason for the costliness of emerald is that it is very brittle, so that crystals unmarred by cracks are exceedingly rare. Pale stones are less valuable than those that are deep velvet green or grass green. Emeralds have the property, rare in green stones, of retaining their colour in artificial light.

The emeralds known to early peoples came from mines in Egypt, in the mountains that are parallel to the Red Sea. These mines were reopened about a century ago, but have produced only poor stones. There are mines in the Ural Mountains in the U.S.S.R., and in New South Wales in Australia; but the finest stones come from Colombia in South America. There the mines are open-cast and are situated at very high altitudes in the midst of tropical jungle. Mining is done by Indian labour.

The largest single crystal of emerald known is hexagonal and about 2 inches both in diameter and in length. It has very many flaws.

See also Colour Plate opposite p. 288.
See also Vol. XI: JEWELLERY.

ENGLAND. 1. GEOLOGICAL HISTORY. The islands of Great Britain, lying off the north-west of the European continent, are surrounded by seas which are nowhere very deep. The islands are, in fact, highlands rising out of a great drowned 'plain' which is part of the continent. The real boundary of the continent lies west of Ireland and Iceland, where the sea suddenly plunges to a much greater depth. In past ages this 'plain' was not below sea-level, and men and animals could pass on dry land from France to England, from England to Ireland in the west and to Scandinavia in the east.

The dates when the islands became separated from the mainland can be calculated to some extent from the types of animal and plant life found, and especially from the remains of extinct species. Ireland, for instance, is very poor in variety of wild animals, and must have split off from Britain before many well-known species had come into existence. Britain is much poorer than the Continent—it has only forty species of mammals compared with ninety in Germany and sixty in Scandinavia. On the other hand, bones and teeth of land animals such as mammoths, reindeer, and bears have been dredged up from the Dogger Bank, showing that, at some period after the Ice Age, what is now the North Sea must have been dry land. Remains of elephants found in Britain (animals which could only have got here by land) prove

THE LAKE DISTRICT: WASTWATER, CUMBERLAND
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that the English Channel must have been formed after these beasts had reached the continent—a time which is known to be later than the appearance of man himself. So the first people to inhabit Britain were able to migrate here on foot, a very long time before man knew how to make boats.

2. General Characteristics. Of the four countries which make up the British Isles England is the largest. It is roughly triangular in shape, stretching at its widest for about 320 miles along the base from Kent to Land's End, and at its longest about 430 miles from the Scottish border to the English Channel. No part of England is more than 100 miles from the sea, and in consequence her history and fortunes have always been closely concerned with the sea.

The highest lands lie to the west. The Atlantic Ocean is continually beating on the rocky and broken west coast of England, Wales, and Scotland, and very gradually wearing it away. On the low and sandy east coast sand and shingle are being deposited by the North Sea, and during the centuries much land has been reclaimed. Far up long inlets, such as the Thames and Severn estuaries, great ports, like London and Bristol (qq.v.), have grown up, well protected from the violence of the sea. On the south coast the chalk hills of southern England end in white cliffs facing the English Channel. The cliffs of Dover, the Seven Sisters, and Beachy Head can be seen gleaming white many miles out at sea.

The sea has been important in the history of England, not only as a protection against the attacks of outside peoples, but also as a valuable source of food-supply. Fishing (q.v. Vol. VI) has always been an important industry, especially in the east, where lie the great fishing ports of Grimsby, Hull, and Yarmouth. The sea also has a considerable effect on England's climate. For more than half the days of the year, south and west winds bring air which has crossed many miles of water. In winter these winds are comparatively warm, since the sea is warmer than the land; in summer, when the land is warmed by the sun, the sea-winds are cool. England, therefore, has a much more temperate climate than the great inland countries, such as Poland and the U.S.S.R. The winds also bring rain throughout the year. The effects of the south-west winds are reduced by their passage over the land to the east of England; and so the average winter temperature in Norfolk is about

THE MIDLAND PLAIN: THE VIEW FROM BREDON HILL, WORCESTERSHIRE
G. M. Boumphrey

older than in Cornwall, and the average ly rainfall drops from 80 to 100 inches in the t to about 30 inches in the east.

he geological structure of Britain exhibits a mber of different types of rock, the main ones ing granite and sandstone, limestone, and alk. The rocks form the uplands, while the lleys between them are filled sometimes with andy soil and sometimes with clay. The great variety in English scenery is due to the fact that different types of rock come to the surface in different regions within a relatively small area, each producing a different land formation and vegetation and, consequently, a different type of agriculture. The chalk downlands and the sandstone country of the Weald in south England produce characteristic and quite different scenery and crops within a small area. The rocks of the Carboniferous Age (*see* EARTH, HISTORY OF, Chart) supply the coal and iron beds which are among England's greatest riches. Some of the oldest rocks in England, which have resisted the wearing-away process of weather, are found in Devon, Cornwall, and Cumberland.

3. NORTHERN ENGLAND. In the Lake District of the north-west, rugged granite hills, with peaks such as Scafell and Skiddaw, over 3,000 feet high, overshadow the valleys in which lie the great lakes of Windermere, Derwentwater, and others. These lake-filled valleys radiate from the central mass of mountains, like the spokes of a wheel. The Lake District is a favourite holiday resort, especially for the congested industrial cities of Lancashire to the south.

The counties of Northumberland, Durham, Lancashire, and Yorkshire are dominated by the Pennine uplands, which are formed of hard limestone and sandstone (millstone grit). The uplands are covered with moorland, but here and there the bare rock comes to the surface in fantastic shapes, called 'scars'. In the limestone country there are underground CAVES (q.v.) and pot-holes. On either side of the Pennines the plains of Yorkshire and Lancashire stretch to the sea. Swift rivers flow down from the hills in steep-sided valleys called 'dales'. These rivers used to provide water-power to run small woollen mills; and so villages grew up, whose people were engaged in washing, dyeing, spinning, and weaving the wool from the moorland sheep. During and since the Industrial Revolution, the seams of coal and iron underlying the foothills of the Pennines have been worked, and steam-power has taken the place of water-power.

A VILLAGE STREET: DORCHESTER, OXON

G. M. Boumphrey

Large ugly towns grew up on the site of the dale villages, and the country-side became shrouded with smoke and scarred with coal and iron workings. The wool industry of Yorkshire, centred in towns such as Leeds, Bradford, and Huddersfield, developed so much that raw wool now has to be imported from elsewhere. The iron-ore goes to the great steel, heavy machinery, and shipbuilding industries of Newcastle, Sunderland, and Middlesbrough at the mouths of the Rivers Tyne and Tees. In Lancashire, the cotton industry, centred in MANCHESTER, manufactures the raw cotton brought over to the port of LIVERPOOL (qq.v.) from America, Egypt, and India.

4. MIDLANDS. South of the Pennines lie other industrial areas, the 'Potteries' and the 'Black Country', both of which are based on the coal-fields of Staffordshire, Derbyshire, Leicestershire, and Warwickshire. In the Potteries china is manufactured, and the famous Etruria works founded by Josiah Wedgwood in the 18th century are situated there. Metal goods, varying from motor-cars and railway engines to pins and buttons, are manufactured in the 'Black Country'. The chief Midlands city is BIRMINGHAM (q.v.).

The Midland plain has rich reddish soil, which makes excellent farming land, especially for dairy-farming. The plain is drained to the north-east by the Rivers Trent and Humber, and to the west by the Dee and Severn. The towns have developed from small market-towns serving the needs of the surrounding country-side, and many of them have fine old buildings of warm red sandstone—a pleasant contrast to the grey squalid factories of some of the northern towns. The grand cathedrals of Chester, Worcester, Hereford, Lincoln, Lichfield, and others show that these districts were rich and prosperous in medieval times. In the east many of the villages and small towns have magnificent 15th-century churches which seem absurdly large for the present small population. These are sometimes called the 'wool churches', because they were built when the wool trade was very flourishing. At this time, too, many

mish and Dutch weavers came over to teach : English their craft—so many, in fact, that : south-east part of Lincolnshire was, and still alled Holland.

n Norfolk, Suffolk, and Cambridgeshire a flat . monotonous land, the Fen country, is ined by sluggish rivers, such as the Ouse, and -crossed by drainage ditches. In old days h of this land was frequently under water, people used to go about on stilts. Now the . black soil has been reclaimed from sea or r, and produces excellent crops of cereals l roots. But even now the country is subject levastating floods, and the ancient town of has been known to be so much under water t people have gone about the streets in boats.

. South England. To the south of the dlands run the limestone (Oolite) Cotswold ls and Northampton Uplands, and then the lk and flint ridges of the White Horse Hills Berkshire Downs, the Chilterns, and the lands of East Anglia. Along the south of gland run stretches of chalk downland, the th and South Downs of Kent and Sussex, the Wiltshire and Hampshire Downs. ween these highlands lie lowlands, generally er of heavy rich clay, such as the Oxford ey or the London Basin (in which more than quarter of England's population is concen- ed), or of poorer sandy soil, such as much he pine-wood districts of Surrey. From the t coast the long estuary of the Thames runs to the great port of London (qq.v.).

To the south-west lie Salisbury Plain, and the rich Hampshire Basin. In this part of England are found some of the oldest British settlements, and traces of prehistoric monuments, such as Stonehenge and Avebury (qq.v. Vol. I), or magnificent Earthworks (q.v. Vol. I) such as Maiden Castle in Dorset. The beautiful old city of Winchester (q.v.) was the capital of the Saxon kingdom of Wessex. Beyond lies the peninsula of Devon and Cornwall. Here ancient rocks make a low plateau, rising to the high moorlands of Exmoor and Dartmoor. In places the rock shows above the moorland soil in peaks called 'tors'. Deposits of copper, lead, and silver ore are mined on a small scale, and china-clay is also found. The coasts are rugged and rocky and provide many good fishing harbours, as well as the excellent harbour of Plymouth, which has been one of the most important bases for the British navy since the days of Queen Elizabeth. The climate is so mild that in sheltered places semi-tropical plants will grow.

During the last 150 years England has changed from an agricultural to an industrial country. Now, of her forty-one million people, only about one in five gets his living by agriculture, and four-fifths live in towns—a large proportion of them either in the industrial north or in Greater London and its satellite towns. Her geographical position, her wealth in minerals, and the energy of her people, all contributed to giving England the leadership in trade and commerce in the 19th century. In the 20th century her position is challenged by other countries, in the New as well as the Old World, who have developed their own industrial resources.

See also Ireland; Scotland; Wales; Geology (Fig.).
See also Vol. I: British Peoples.

EQUATOR, *see* Earth.

EQUINOX, *see* Astronomy, Modern, Section 4.

ERITREA. This north-east African country, about half the size of Great Britain, stretches for some 670 miles along the south-west shore of the Red Sea (q.v.), (*see* Map, p. 5). Valuable pearl-fisheries are worked from its coast and the adjacent islets. The coastal lowland has a tropical climate with sufficient rain to allow cultivation. In the south, Italian settlers have irrigated the land, so that better crops of flax, tobacco, cotton, and cereals are produced. Inland, steep slopes lead up to the Abyssinian plateau in the north, and to lower plateau country in the south, where, in a cooler climate, a mainly nomadic population raise sheep, cattle, and camels.

Asmara, the capital and largest city, situated on the northern plateau, is an important trading centre. There are gold-mines near by. Massawa, the principal port, serves not only Eritrea but also Abyssinia (q.v.).

EROSION, *see* Denudation, Section 2; Soil Erosion.

ESTONIA. The Soviet Socialist Republic of Estonia lies south of the Gulf of Finland on the shores of the Baltic Sea (*see* Map, p. 160). Its area of 18,000 square miles holds a population

TALLINN, ESTONIA
One of the medieval gates of the city
E.N.A.

of over one million. There are two large and several small islands off the mainland. It was an independent republic from 1920 till 1940.

In the north there is a low limestone plateau, partly wooded, on which the main crop is potatoes. The plains of the south have poor soils, so that pasture and fodder crops for dairy cattle are more important than the flax, rye, barley, and oats which are also grown.

There are oil-shale deposits in the plateau. Electricity is generated by water-power from the River Narva, which flows from Lake Peipus at the eastern edge of Estonia to the Gulf of Finland. Narva, on a hill overlooking the river, and Baltiski manufacture textiles and export timber.

The capital is Tallinn (or Reval), at the entrance to the Gulf of Finland. It can be kept open all the year round, and is, in consequence, an important U.S.S.R. port. Its high houses with their steep-pitched roofs, its towers, churches, and guild-halls, recall the days when it was an important town of the HANSEATIC LEAGUE (q.v. Vol. VII).

See also U.S.S.R.
See also Vol. I: ESTONIANS.

ETHER, *see* LIGHT.

ETHIOPIA, *see* ABYSSINIA.

ETNA. The great lava and ash c[illegible]f the volcano of Etna towers high over th[illegible]nd of SICILY (q.v.), rising majestically from [illegible]rrow coastal plain on the east of the islan[illegible]bout 10,740 feet. The volcano is surro[illegible]l by several hundred subsidiary cones, a[illegible] the eastern side there is a great chasm, [illegible] the Valle del Bove, 3 miles long, 2 miles [illegible] and about 4,000 feet deep. It is from the [illegible] del Bove or from one of the subsidiary c[illegible] that there is the greatest danger of eruptio[illegible]rom the summit crater steam is ejected at [illegible]uent intervals, and during eruptions lava po[illegible]rth. Ash is showered out less frequently, t[illegible]h in 1940 there was a severe ash eruption. T[illegible]hole volcano has a circumference of nearly 1[illegible] miles at its base.

Etna has a very long history. The [illegible]rliest recorded eruption is believed to be as [illegible] ago as 1500 B.C. Since then, at frequent int[illegible]s, it has poured forth destruction on the [illegible]ntry around. The last serious eruption was i[illegible]928, when whole villages were destroyed [illegible]low-moving floods of molten lava. When an [illegible]tion is over, however, the villagers begin [illegible]reep back again, lured by the richness of t[illegible]rtile lava soil, well watered from springs fed [illegible]rain and melting snow, until the lower slope[illegible] the volcano are as densely peopled as ever.

The lava streams vary in composition: [illegible]ome weather rapidly into extremely fertile soil; [illegible]ners remain barren and rocky, stretching [illegible] in tongues down the mountain-side among [illegible]sts,

MOUNT ETNA
P. Hart

eyards, and a great variety of cultivation. e summit of Etna, from about 9,200 feet wards, is snow-covered for much of the year. m this line down to about 6,000 feet the pes are covered with thorny brushwood and wering shrubs. Then comes an area of what d to be mixed forest, but is now mainly cken and scrub. On the lower slopes the land intensively cultivated, sometimes terraced, n with dry stone walls of lava blocks. There vineyards and orange and lemon groves, and the north and west slopes, olive groves and ls of grain.

also VOLCANOES.

PHRATES RIVER, *see* IRAQ.

ROPE. The continent of Europe is bounded a to the north, west, and south. On the east Ural Mountains and the Caspian Sea form raditional boundary between Europe and Thus Europe includes the old 'Russia', orical centre of the U.S.S.R., but does de the vast stretches of Asiatic Russia. h less compact in shape than the other ts and has a very long coastline. With a of 3,750,000 square miles, and about illion inhabitants, it is the next most y populated continent after Asia. Europe hanged its shape considerably during the of its history. Until shortly after the ICE (q.v.) it must have been possible to cross hod from France to Britain over the English nnel and from Britain to Scandinavia over the North Sea. Indeed, there is some geological idence that there was once a range of mountains running across the north Atlantic to North America, of which Iceland, the highlands of Scotland, the north Atlantic Islands, and Scandinavia are perhaps the remains (*see* EARTH, HISTORY OF). It is also possible that at one time the Mediterranean Sea was dry land, broken up with lakes and marshes, and that early types of animals may have passed from Africa to Europe.

Europe is a continent favoured by nature. It has warm winters for its latitude, a high proportion of land suitable for agriculture, and no great waste areas of desert. It is rich in mineral wealth, especially in coal and iron, and it has few great natural barriers, so that ideas and peoples have mingled freely. Europe has been one of the great centres of world civilizations. Many of its people have been seafarers, and from its shores explorers have ventured forth in all directions, eventually to discover the whole world. Consequently Europe has been for many centuries the centre of culture and trade for much of the world.

The structure of Europe, the arrangement of its mountains and lowlands, is very complex. In the north-west, high mountains of old hard rock occupy most of the Scandinavian peninsula, north-west Britain, north-west Ireland, Wales, and Brittany. Much of this area is covered by barren rocks and moorland. The shallow North Sea and Baltic Sea separate Scandinavia from the great European plain which stretches across Finland and Russia to the Black Sea, and includes Poland, Denmark, and northern Germany, Holland, Belgium, and much of France, and south-east England. Here and there it is broken up by low rolling hills and occasional marsh and moorland. The greater part of this plain is agricultural land, and some of it is the most fertile land in Europe.

The rest of Europe is hilly or mountainous, except for two plains, the triangular-shaped plain of the River Po in north Italy, and the broad, flat plain of the middle Danube. South of the great European plain are the mountain blocks of central and south-east France and south Germany. To the south of these again are the ranges of the Pyrenees, the great curving chains of the Alps and the Carpathians, the long backbone of the Apennines in Italy, and the parallel ranges of the Balkan Mountains. However, these mountain barriers are so cut by river valleys and gaps, that no part of Europe is completely isolated. Mountains are the background of almost every Mediterranean landscape, and small coastal plains drained by short, swift rivers are typical of all Mediterranean countries.

There are three main climatic regions in Europe, each with its own natural vegetation and agriculture. Europe north-west of the River Elbe in Germany has rain at all seasons of the year: the natural vegetation is deciduous woodland, and meadowland suitable for cattle and sheep-farming; in many parts cereals and root-crops are also grown, and orchards of apples, plums, and pears have taken the place of some of the woodland. Eastern Europe has much colder winters and hotter summers than western Europe—in northern Russia the rivers are frozen in winter and the ground is snow-covered for several months. Coniferous forests cover

ICELAND
Reykjavik
Faeroe Is.
Shetland Is.
Orkney Is.
Hebrides
SCOTLAND
Glasgow
Edinburgh
N.I.
Belfast
Dublin
EIRE
Liverpool
York
ENGLAND
WALES
Birmingham
London
ENGLISH CHANNEL
ATLANTIC OCEAN
NORTH SEA
Lofoten Is.
Trondheim
Bergen
Oslo
Falun
Stockholm
Helsinki
Viipuri
Gulf of Bothnia
NORWAY
SWEDEN
FINLAND
Skagerrak
Kattegat
DENMARK
Copenhagen
Kiel
BALTIC SEA
Danzig
Warsaw
POLAND
Vistula
Oder
Elbe
Berlin
GERMANY
Leipzig
Prague
Cracow
Dniester
The Hague
HOLLAND
Rhine
Brussels
BELGIUM
LUXEMBOURG
Paris
Seine
Loire
BAY OF BISCAY
FRANCE
Bordeaux
Pyrenees
Rhône
Marseilles
CZECHOSLOVAKIA
Vienna
Bratislava
Munich
AUSTRIA
Budapest
HUNGARY
ROUMANIA
Berne
SWITZ.
Alps
Venice
Milan
Po
Genoa
Florence
ITALY
Apennines
ADRIATIC SEA
Rome
Naples
Corsica
Sardinia
Palermo
Sicily
Catania
Malta
YUGOSLAVIA
Danube
Dubrovnik
Sofia
BULGARIA
Burgas
Rhodope Mts
Durazzo
Tirana
ALBANIA
Salonika
GREECE
AEGEAN SEA
Athens
TURKEY
BLACK SEA
Dodecanese
Crete
Oviedo
Cantabrian Mts
Oporto
PORTUGAL
Tagus
Madrid
Ebro
SPAIN
Lisbon
Guadiana
Sierra Morena
Guadalquivir
Seville
Granada
Sierra Nevada
Malaga
Gibraltar
Barcelona
Balearic Is.
Majorca
MEDITERRANEAN SEA
Land over 0 feet
Miles
0 100 200 500
70
60
50
40
20
0

EUROPE

…ch of the northern part, and agriculture is …ied on only in small clearings. South of the …sts are the great grassy plains (called steppes) …ich continue south across the basins of the …ieper, the Don, and the Volga. These steppes …e rich soil, and are now one of the most …ortant grain districts in Europe. Mediter…an Europe generally has mild, wet winters … hot, dry summers: many of the trees are …greens, and there are few forests, except on … mountain-sides; vines, olives, oranges, and …ons are characteristic of the area; grain is …n, but on the whole it is too dry for dairy…ng.

…e rich coal and iron deposits of Great Br…ain, France, Belgium, Germany, Czecho…kia, and Russia have become very im…tant in the last 150 years, and have led to the g…th of densely populated industrial districts. … a very large proportion of Europeans are …untry dwellers, making their living on the … In such parts the old towns are centres for …ounding country, the common unit being … agricultural village.

…volume includes separate descriptive … on all the countries of Europe, as well … main towns, rivers, and mountains; and …lume I are given articles on all the …nt peoples.

…REST. The highest mountain in the world, …unt Everest, is a peak of the eastern Hima…s (q.v.) and lies on the border of Tibet and …pal. Its position and a height (since super…led) of 29,002 feet were calculated in 1849 and 1850 from numerous careful observations by instruments set up by members of the survey of India more than a hundred miles away.

As a result of calculations made in 1954, the height of Everest is recognized as 29,028 feet. The peak was named by Sir Andrew Waugh, Surveyor-General of India, after his great predecessor, Sir George Everest.

Since the closing years of the 19th century British climbers (to whom is due the development of Mountaineering (q.v. Vol. IX) as a sport) have had the ambition to conquer Everest and stand on the highest part of the globe.

Nothing was known of the immediate neighbourhood of Everest or of the conditions likely to be met on the mountain itself. A Hindu explorer, Hari Ram, had passed 20 miles to the west of it in 1885, and Colonel Ryder of the India Survey was within 50 miles of it, to the north, in 1902. It was suspected that any attempt to climb up the southern face would meet insuperable mountaineering difficulties, and that the attempt would have to be made from the north: beyond this, almost everything awaited exploration. Before the physical odds could be tackled or even estimated, permission to make an expedition had to be won from the rulers of Tibet or Nepal. At first both were suspicious of the enterprise, and refused; but in 1920 the Dalai Lama of Tibet finally gave permission for an attempt to be made.

Expeditions were organized by the Alpine Club in conjunction with the Royal Geographical Society. The object of the first one, in 1921, was to make as thorough a survey as possible of the mountain and its surroundings—above all, to try to work out a line by which a subsequent expedition might hope to succeed. The giant peak rises up out of a confusion of lesser summits and ridges which, from most angles, hide it from view except from much too far away for any details to be seen. All are usually hidden soon after noon by the clouds which rise from the hot plains and steamy valleys of India and Nepal. Even that part of the Tibetan plateau to the north of the mountains—from which the approach would presumably be made—was practically unknown. This expedition did all that was expected of it. The approaches to the mountain from the north, the north-east, and the north-west were surveyed and roughly mapped. This survey indicated that the best line of attack was towards the north-east shoulder of Everest by way of the North Col (23,990 feet), a depression in the northern buttress between Mount Everest and its North Peak. This has been the route followed, except for minor deviations, by all expeditions until 1949.

By this route much of the last part is over slabs of rock slanting steeply downwards and outwards like the tiles on a roof. They offer no handholds or projections round which a rope might be belayed: the climber has to trust to the grip of his nailed boots and to his sense of balance. The difficulties of climbing under these conditions are prodigious. In the 1924 and 1933 expeditions climbers reached over 28,100 feet but were forced to retreat through exhaustion. Mallory and Irvine lost their lives in the second attack of the 1924 expedition. It is thought that they were seen, through a break in the cloud,

NORTH COL CAMP AND THE NORTH PEAK
Mount Everest Expedition, 1921–4
Royal Geographical Society

at a height of about 28,230 feet. The only clue to their fate has been Mallory's ice axe which was found 9 years later by the expedition of 1933—and this revealed nothing.

In 1949, at a time when the possibilities of any further success from the north had become slight, the frontiers of Nepal were opened to foreigners. The second of two reconnaissance expeditions reported in 1951 that they believed they had found a possible route up Everest from the south. This route was tried unsuccessfully by a Swiss expedition in two attempts in 1952. The 1953 expedition was organized by the Alpine Club and the Royal Geographical Society, and consisted of fourteen climbing members, eleven of them British, two New Zealanders, and one a Sherpa. Edmund Hillary and the Sherpa Tenzing succeeded in reaching the summit.

Hardly less uncertain than the face of the mountain itself was the effect on the human body of the prolonged effort of climbing at such immense heights. Mont Blanc, the highest peak in Europe, is only 15,782 feet: the uplands from which an ascent of Mount Everest starts are well over 10,000 feet or two-thirds of that altitude, while Everest itself is almost double. At such a height the amount of oxygen in the ATMOSPHERE (q.v.) is only about a third of that at sea-level. Successive expeditions had proved that the human body, given time, can acclimatize itself enough to achieve short periods of exertion at great heights. Indeed, in 1924 the height of 28,000 feet was reached without oxygen apparatus. However, any length of time spent at heights above 23,000 feet results in a decline in physical fitness, marked by progressive weakness and non-recovery from fatigue. The physical strain of going above 26,000 feet is so great that to recover completely from it takes many weeks.

Oxygen apparatus had been taken on all Everest expeditions except the reconnaissance of 1921, but until the Swiss attempts in 1952 the conclusions drawn from its use were that the weight of the apparatus counterbalanced any help it might give. The successful expedition of 1953 used three types of oxygen apparatus, two for climbing and one for use when sleeping. It was found that the use of oxygen when climbing enabled the effort per day to be increased while reducing fatigue, and the use of it while sleeping allowed the climbers to recover from fatigue and enabled them to stay longer at high altitudes. It must be remembered, however, that the two climbers who reached the summit spent some ten minutes there with their masks of[f].

Weather conditions limit attempts on Everest to two short periods in the year.

The MONSOON (q.v.) usually reaches the Himalayas by about mid-June, and the north face of Everest is then covered with snow until it is blown clear again by the return of the west wind which prevails from the end of the monsoon in mid-October. The last part of the climb is clearly too difficult to be attempted under a covering of snow. It has generally been accepted that Everest has to be tackled before the beginning of the monsoon, for, by October, the days are too short. The Swiss expedition of 1952, however, made a second attempt after the monsoon. In general, expeditions planned to reach their Base Camp in mid-April, which gave them 2 months for the actual attempt on the mountain. In that time six higher camps were pitched and provisioned, climbers and porters were acclimatized, and the final assault on the summit made.

Everest expeditions require most elaborate organization, consisting as they do of upwards of ten climbers (including at least one doctor),

EVEREST FROM THE BASE CAMP
Mount Everest Expedition, 1921–4
Royal Geographical Society

pas, who climb as well as carry loads, and dreds of native porters, mostly hill tribesmen. ny tons of stores and equipment have to be lected and packed, some items being specially signed and manufactured. For their transport the Base Camp, arrangements have to be ade for the hiring of some 300 pack-animals—onies, mules, oxen, and yaks. Beyond the Base amp everything has to be carried by hand. he plan followed is to establish a chain of amps upwards towards the summit at intervals of between 1,000 and 2,000 feet. The successful 1953 expedition established in all nine camps, the highest at 27,900 feet. The first assault team of two men set out from Camp VIII on the South Col, on May 26th. They were determined and full of hope although the weather was unfavourable. There were clouds around them and snow was falling. They reached the south summit of Everest, a point higher than anyone had yet climbed, over 28,700 feet, and could see the ridge that still had to be climbed, but knew that they had not time to do it.

On May 28th, Camp IX was established on the south-east ridge, and Hillary and Tenzing spent the night there. The next morning they set off for the south summit, which they reached in two and a half hours. The weather was good, and above them rose the ridge to the summit of Everest—a narrow, steep, snow-covered ridge, broken by a 40-foot rock step. On the right great cornices of snow and ice overhung a 10,000 foot drop. On the left precipitous slopes fell to the western cwm of Everest. The snow of the ridge was crystalline and firm, making it possible to cut steps. The two men climbed on, and in less than three hours they reached the summit. They had conquered Everest.

See also Vol. IV: Exploration.

EVOLUTION, *see* Earth, History of. *See also* Vol. II: Evolution.

F

FAEROE ISLANDS. These islands, lying in the North Atlantic Ocean between Iceland and Scotland (*see* Map, p. 160), belong to Denmark. There are twenty-one of them, though four are uninhabited except by flocks of sheep taken there to pasture in the summer.

The islands are very striking in appearance. High cliffs and headlands rise precipitously above the sea, and on their rocky ledges thousands of sea-birds nest. Collecting their eggs is an important Faeroese occupation, and a dangerous one, for it entails scaling hundreds of feet of high cliffs with the slender protection of a rope. Fishing employs many of the men.

COTTAGES ROOFED WITH TURF AT VESTMANNA HARBOUR, FAEROE ISLANDS

Royal Danish Ministry for Foreign Affairs

Potatoes and a little barley are the main crops. Peat is plentiful and used for fuel. The capital of the Faeroe Islands is Thorshavn, on Strömo, the largest of the islands.

FALKLAND ISLANDS. The Falkland Islands lie in the South Atlantic Ocean, off the coast of Patagonia opposite the eastern end of the Magellan Straits (*see* Map, p. 415). The two large islands, East Falkland and West Falkland, are surrounded by many small ones. They have very jagged coastlines with many good harbours.

The Falklands lie so far to the south that they are within a thousand miles of the Antarctic Circle. Their climate is bleak and depressing. Most of the year they are swept by gales, and there is frequent snow. The islands are covered with wild moorland and rock, and trees cannot grow on them. No agriculture is possible: the inhabitants, of which there are about [illegible], are nearly all occupied in sheep-farming, and the country is divided into large sheep-runs. The only town, Stanley in East Falkland, is small and has houses built of iron and wood. Outside the town there are no roads, and the traveller has to depend on natural landmarks. The islands produce very little food except mutton and penguins' eggs, and practically everything is imported from Montevideo in URUGUAY (q.v.), more than a thousand miles away to the north.

These islands are a British colony. For many years France, Britain, Spain, and Argentina disputed their ownership, and several times they were occupied and afterwards abandoned. At last, the British reoccupied them in 1833. Now, the British occupation of the Falklands and parts of the Antarctic is being disputed by Argentina and Chile. The Falklands have been valuable as a port of call and a coaling station for ships, especially when ocean traffic between the Atlantic and Pacific had to go round Cape Horn, before the PANAMA CANAL (q.v. Vol. IV) was built. The naval importance of the Falklands was shown by the Battle of the Falkland Islands at the beginning of the First World War, when a British fleet met there and destroyed the German squadron under Admiral von Spee, which had been raiding in the Pacific.

There are several British possessions in the Antarctic which are governed from the Falkland Islands—South Georgia, South Orkney Islands, South Sandwich Islands, South Shetland Islands, and Graham Land. These are covered with snow

a… ice, and uninhabited, except for whaling set…ments. They are the centre of the world's gr…test Whaling industry (q.v. Vol. VI), for m… whales are caught in the seas round them th… are caught in the rest of the world. R…ntly deposits of uranium have been found, a… this greatly increases their importance.

…also Polar Regions.

…LT (Geology), *see* Rock Formation.

…DSPAR, *see* Minerals, Section 2.

… *see* Marsh and Moorland.

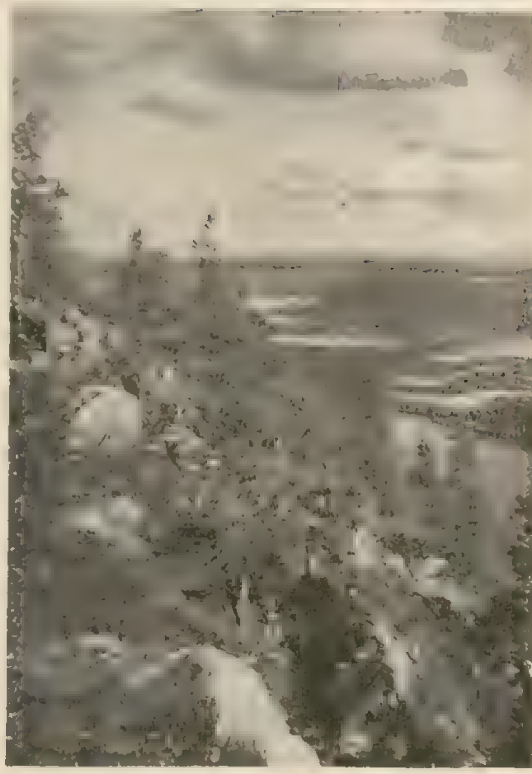
… *see* Morocco.

F… ISLANDS, *see* Pacific Islands.

F…LAND (Suomi) lies between Sweden and the … R. (*see* Map, p. 160). Until 1809 it was …ed by Sweden. Then it became a Grand D…y of Russia until, after the Russian …tion, it became independent, and a re…lic was set up. Finland is mainly a rolling, fo…ed, granite plateau, with many thousands … s. The hollows in which these lie were …d out by ice during the Ice Age (q.v.). As m… as a quarter of southern Finland is water. … north of Finland is desolate, and peopled m…y by nomadic tribes of Lapps (q.v. Vol. I). M…h the majority of the population of rather m… than 3½ millions live in the centre and s… of the country. The coasts are bordered b…ry many islands, some of which are wooded wi… mountain-ash, pine, and birch, while oth…rs are bare and rocky.

Finland has a long and severe winter, during which sleighs are the usual means of transport. In the summer, which is short, there are steamers on the lakes, which are often connected by rivers or canals. It is possible to go from Viipuri (Viborg) on the Gulf of Finland to Jisalmi far inland by little steamers which wind through channels between rocks and forested islands. In many places, a river or lake cascades into another lake in a magnificent waterfall. This power is used to generate electricity.

Timber from the many thick woods and forests is the most important export. It is also largely used for building, furniture-making, the manufacture of paper, wood-pulp, cellulose, and the extraction of resin and tar. Rye is the most important agricultural crop. There are many dairy farms, and before the Second World War a great deal of butter was exported.



LAKES AND FOREST LAND IN FINLAND

Paul Popper

As the factories are driven by electricity made by water-power, the cities are very clean. Helsinki (Helsingfors) is one of the most northern capitals in the world. It has broad streets with fine, modern granite and brick buildings, and a big, deep harbour penetrating well into the city. Turku (Abo), which was the capital in the days of Swedish rule, has a fine cathedral and castle of 13th-century Swedish architecture. One of the two universities in Turku is for Swedish-speaking students. In the country most of the houses are one-storeyed and built of wood. Their roofs are steep-pitched so that snow may slip off readily.

See also Vol. I: Finns.

FINNO-KARELIA. The Soviet Socialist Republic of Finno-Karelia lies to the west of the Russian Soviet Federative Socialist Republic, and its north-east frontier is the White Sea (*see* Map, p. 459). It is a land of lakes and forests,

very like Finland and south Sweden. GLACIATION (q.v.) has removed most of the soil. In the north, rivers are swift-flowing, and their many waterfalls are frequently harnessed to provide electricity. In the south, ancient glaciers have left low hill country with lake-filled hollows. Lake Ladoga is the largest lake in Europe.

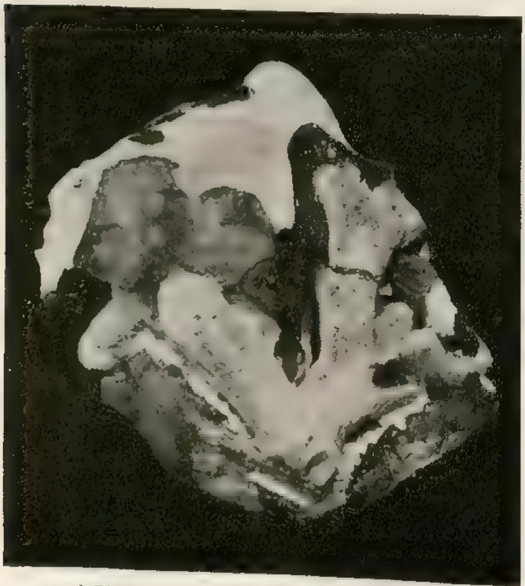
The forests, mainly of fir, birch, and pine, which cover nearly three-quarters of Finno-Karelia, are being exploited not only for timber for export (and this is the chief source of export timber in the U.S.S.R.) but also as raw material for the manufacture of paper and cellulose. On the shores of Lake Onega there are quarries from which building-stone has been transported to many parts of Europe. Mica and iron are also mined, Petrozavodsk, the capital, having been for centuries an iron (and later, a steel) town. Many of the rivers of Finno-Karelia are salmon rivers, and in the north there is a flourishing canning industry. In the south, barley, rye, and oats are grown, and dairy-farming is important.

See also U.S.S.R.

FIORDS, *see* COASTS.

FLANDERS, *see* BELGIUM.

FLINT. This rock consists of silica in non-crystalline form—the crystalline form being quartz.



A FOSSILIZED SPONGE EMBEDDED IN A FLINT
University Museum, Oxford

The silica from which flint has be derived was originally the skeletons of spon These dissolved, and the silica was re-d ited in bands of flint. Flint may be found regular layers in chalk. When the irregular y lumps are broken into small fragments, th usually disclose, somewhere in the middl a fossil sponge, round which the silica was posited gradually. The flint layers, therefore, obably represent beds in which fossil sponge re particularly abundant on the sea floor.

Flint has been of considerable imp ance in human history. Because it breaks into kes and fragments with very sharp edges, it wa sed for the making of knives, spearheads, a many other tools and weapons in the earl days o mankind (*see* PREHISTORIC TOOLS AND APONS, Vol. I). Flint was also used for makin e, and until recently houses were often buil flints set in mortar. To-day flints are heate n kilns to produce soft white silica powder for t manufacture of white porcelain tiles.

When exposed to the weather, flint velops a white matt surface by the dissolvi of the silica from the exterior layers. The th ness of this white layer gives some idea of the gth of time the flint has been exposed to the ather, and from this some idea can be obtain of the age of flint implements. Flints were u d from the days of prehistoric man to histori times.

See also LIMESTONE; MINERALS; ROCKS, Secti 3 (*e*).
See also Vol. I: PREHISTORIC TOOLS AND WEAP

FLORENCE (FIRENZE). This town in north-central Italy represents, perhaps better than any other town, the greatness of the Italian Renaissance. Florence is not a big city. Her history does not date back into the ancient past as does ROME (q.v.), nor was she ever an important European power as was VENICE (q.v.). Her greatness as a city-state lasted from about the 12th to the 16th century. During this time she fulfilled the conditions most favourable for artistic expression. She grew very prosperous by trade, and especially by banking and money-lending. She developed a very keen civic pride, and for a time her fortunes were directed by the highly cultured and wealthy banking family the MEDICIS (q.v. Vol. V), whose wise patronage was responsible for much of the fine building, sculpture, and painting, as well as for the work of scholars and writers.

The greatest Italian poet, DANTE (q.v. Vol.

THE CAMPANILE, FLORENCE
Behind it is the dome of the Cathedral
P. Hart

, was born in Florence, though in fact he ote his finest work away from his native city, he was driven out in 1301, during one of the quent political upheavals which were a feature of Florentine history. Among the best known of her artists are Giotto, Michelangelo, and Leonardo da Vinci (qq.v. Vol. V), as well as a great host of others nearly as well known. The great religious leader Savonarola (q.v. Vol. V), after stirring the Florentines to enthusiasm by his preaching, was burnt by them at the stake in the Piazza della Signoria in the centre of the city.

Florence stands on the River Arno, which flows through the centre of the city and is crossed by many picturesque bridges. The most famous of these is the Ponte Vecchio (Old Bridge), which has houses and shops built on it, as the old London Bridge once had. Florence has so many fine buildings that it is difficult to select any for description. The great Cathedral, the Duomo, was built during the period 1298 to about 1460. Its most striking feature is its magnificent dome. Next to the Cathedral stands Giotto's famous Campanile (bell-tower) begun in 1334, admirable for its graceful design and for the wonderful detail of its decoration. The Palazzo Vecchio (Old Palace), a fortress-like palace begun at the end of the 13th century, is filled with the works of many of the great artists of the 15th and 16th centuries. The Bargello Palace, once the residence of the chief magistrate of the Republic of Florence, is now a museum. The art galleries, the Uffizi and the Pitti (also originally a palace), house two of the greatest collections in Europe. The church of San Lorenzo has some of the most famous sculptures of Michelangelo; the church of Santa Croce is rich with the paintings of Giotto; and in the monastery of San Marco is the work of Fra Angelico (q.v. Vol. V).

The character of the hilly country round Florence can be seen in many of the paintings of Florentine artists. Picturesque little towns and villages, such as Fiesole, are perched on the hill-tops near the city. Rather farther afield are the lovely towns of Pistoia, Lucca, and Prato.

FLORIDA, *see* United States of America.

FLUOR-SPAR, *see* Minerals, Section 4.

FOG. This may be formed mainly either of particles of solid matter, such as smoke and dust, or of minute droplets of water such as Clouds (q.v.) are made of. The first type, found usually in and near large towns and industrial areas, varies in colour from yellow to almost black, and may pain the eyes and throat, owing to the sulphur and other chemicals it contains; the second is white and is far less unpleasant. Generally a land-fog is a combination of both types—and in any case the presence of a small amount of dust (such as is always present in the air) is needed for the condensation of the Water-vapour (q.v.). For any sort of fog to persist there must be an absence of wind or of rising 'convection' currents, which would carry it away. Since the atmosphere is mainly warmed by heat reflected back from the earth's surface, the lower levels are normally warmer than those above them. There is therefore a tendency for this warmer expanded air to rise by 'convection'

(*see* HEAT, Section 4) and so to keep a certain circulation going. When for any reason there is a layer of warmer air already resting above—a state of affairs known to weather experts as an 'inversion'—this acts as a barrier to upward convection currents. Then the smoke of cities may be trapped and hang low over the house-tops or form a real 'pea-souper' in the streets. Just under the inversion layer a broad unbroken sheet of 'stratocumulus' cloud (*see* CLOUDS, Section 2) may add still further to the gloom. This cloud is caused by the warm moist air above being cooled by contact with the colder air below.

The condensation of water-vapour into fog or mist is caused by the temperature of a body of air being lowered to a point, called the 'dew-point', at which it can no longer hold in the form of gas all the moisture it contains. On clear nights, when there are no clouds to reflect back heat lost by radiation, the ground can lose its heat so rapidly that the layer of air immediately above it is cooled below dew-point. Then there is condensation and the familiar ground-fog of late summer and autumn occurs, as well as DEW (q.v.). In summer the early rays of the rising sun may set up very slight convection movements in the otherwise still air, and thus by increasing its contact with the chilled ground cause early morning mists.

A quite different sort of fog is the typical sea-fog, most frequent in late spring and summer before the seas round our coasts have had time to warm up. If a body of warm moisture-laden air from the south-west Atlantic reaches our neighbourhood, contact with the colder sea lowers its temperature below dew-point; convection cannot take place, because the bottom layer is the colder—an 'inversion'—and so condensation and fog occur. When such a sea mist drifts over the land, it usually disperses in a mile or two, because at such times of the year the land is warmer than the sea. Some of the thickest fogs of all occur off the coast of Newfoundland. Here the warm air of the Gulf Stream flows over cold air from the Labrador Current, and great condensation takes place. The presence of ICEBERGS (q.v.) has a marked effect in cooling the air around them. This often leads to their being shrouded in fog and, consequently, of great danger to shipping.

Fogs are described in terms of the distance over which known objects can no longer be seen. The scale below is that in common [illegible]

	[illegible]bjects not [illegible]isible at
0 Dense fog	[illegible] yards
1 Thick fog	[illegible] "
2 Fog	[illegible] "
3 Moderate fog	[illegible] "
4 Mist or haze	[illegible] "
5 Poor visibility	[illegible]½ miles
6 Moderate visibility	[illegible]¼ "
7 Good visibility	[illegible]½ "
8 Very good visibility	[illegible] "
	[illegible]jects [illegible]ble at
9 Excellent visibility	[illegible] miles

See also WEATHER.

FÖHN WIND. This is a warm dry wind which sometimes blows down the northern slopes of the Alps, and by raising the temperature many degrees causes a thaw. Winter-sports enthusiasts have reason to dread its arrival, with the consequent melting of snow and ice. The reason why it arrives as a dry wind, when it starts out as a wet one, is rather interesting. The warm moist winds associated with a cyclonic disturbance over Europe (*see* WEATHER) sometimes cross the Alps. To do so, they have to rise to a considerable height. During the ascent, cooling takes place and condensation soon begins (*see* CLOUD). The rate of cooling is about [illegible]° F. for every 1,000 feet, allowing for much condensation of water-vapour into cloud, which causes the release of 'latent heat' and so slows up the cooling (*see* HEAT, Section 5).

But when the wind starts to descend the northern slopes it is much drier, because of the water-vapour it has lost by condensation, and this means that it will warm up (by the increasing pressure on it at lower altitudes) more quickly than it cooled down on the ascent. It will, in fact, warm up at the rate of about 5·4° F. for every 1,000 feet.

Let us suppose that a warm moist southerly wind begins to ascend the Alps at a temperature of 55° F. It is fully saturated and cools below its dew-point (*see* WATER-VAPOUR) directly it begins to rise. It has to rise 10,000 feet, so that at the cooling rate given above its temperature falls to 25° F., at the summit. The descent now begins, and after a drop of 4,000 feet the temperature, rising at the drier rate, has reached 46·6° F., or, say, 44° F. (allowing for

some cooling by contact with a cold ground surface). After a further drop of 3,000 feet it is ... 60° F.—well above the temperature at ...h it started to rise.

... wind of similar type is encountered in the ...ry mountains, but there it bears the name ...e 'Chinook'.

...RESTS. 1. In many parts of the world, ...e the climate is suitable, forests are the ...ral vegetation; and before man for his ... purposes cleared large areas, much more ...e world's surface was covered with forest-

...ere are three main types of forest. In lands ...and near the Equator, where the climate is ... and wet throughout the year, there are ...ests of broad-leaved evergreen trees. In ...al climates where there is a dry season, and ...temperate lands where winter stops tree-...th for several months in the year, are found ...s of deciduous trees, which shed their leaves ...art of the year. Since these are the lands ...ch have been most exploited by man for ...ulture and industry, great areas of forests have been cleared. Finally, where there is a very long, cold winter and a short growing season, ...iferous (cone-bearing) forests predominate. ...e are evergreen trees with small needle-...ped leaves. On forested mountain slopes the type of forest varies according to the altitude. ...ountains within the tropics may have their ... slopes, especially the slopes facing the prevailing rain-bearing winds, covered with lux-...ant equatorial evergreen forest; but their higher slopes, provided the mountain is high ...ough, may be covered with coniferous forest. There is naturally no hard-and-fast line between the various types of forest, any more than there is between forest and grassland. Near their margin these forest types merge into each other, and give rise to many different sub-types, varying according to local conditions of climate, soil, and altitude. Some deciduous trees may be found in a predominantly broad-leaved evergreen forest, and conifers are often scattered in deciduous forests.

2. Broad-leaved Evergreen Forests. These are often called Rain Forests, since they are dependent on a heavy rainfall, as well as on high temperatures. Great areas of dense forest are found in the Congo basin and Guinea Lands of Africa, on the west coast of Malaya and the

EVERGREEN RAIN FOREST IN MALAYA

East Indies, and in the Amazon basin (qq.v.), where they are called 'selva'. There is a great variety of trees, some of them over 100 feet high, growing closely together. Their foliage forms layers or 'storeys' of different heights, and all are striving to get their share of sunlight. The interior of the forest is dim, and the atmosphere damp and steamy. The undergrowth, though well supplied with moisture, is starved of light, and is for the most part fleshy and pale. Much of it consists of 'lianas', climbing plants with rope-like stems which wind round the trunks of the trees and hang in festoons from their branches. There are also many fungus-like plants called 'epiphytes', which feed on decaying vegetation or grow as parasites on living trees (*see* Parasitic Plants, Vol. II). Wherever there is a gap in the forest, caused perhaps by fallen trees, the undergrowth springs up thick and vigorous. Movement in the forest is made so difficult by the tangled undergrowth, fallen trunks, and the marshy soil, that rivers are the main highways. The most valuable trees are the rosewood, ebony, mahogany, camphorwood, and cinchona (from the bark of which quinine is extracted), but as these are generally scattered widely, the difficulty of extricating them from the dense forest is often too great. Rubber trees, and oil and coco-nut palms, which also belong

DECIDUOUS FOREST: BURNHAM BEECHES, BUCKS.
The Times

CONIFEROUS FOREST: BRITISH COLUMBIA
Canadian National Film Board

to this type of forest, are often grown in plantations so that their products may be more easily exploited (*see* TROPICAL JUNGLES, Vol.

3. DECIDUOUS FORESTS. These trees lie dormant during those parts of the year which are too cold or too dry for growth, and during this dormant period they shed their leaves. At the beginning of the rainy season or with the coming of spring and warmth, they put out young leaves and resume growth. There are two types: (*a*) Tropical Deciduous Forests, and (*b*) Temperate Deciduous Forests.

(*a*) Tropical deciduous forests are found in the monsoon lands, particularly in INDIA, BURMA, and south-east ASIA (qq.v.). There is not so great a variety of trees as in the rain forests, but, especially in the wetter areas, the forest is nearly as dense. As the dry season lengthens, the forest becomes thinner. Valuable hardwoods such as teak are found there, and also many kinds of bamboo, much used for native building.

(*b*) Temperate deciduous forests are now not so extensive as the other types of forest. In Britain and western Europe, where the climate is particularly suitable, they are merely remnants of the much greater forests of the past. Forests of this type also occur in Australia, New Zealand, and south Chile. They are made up of trees such as oak, beech, ash, maple, chestnut, elm, and sycamore, and these often grow in 'stands', that is, groups of one kind of tree growing together. In England, for instance, stands of oak largely make up the New Forest of Hampshire and Epping Forest of Essex, and beeches are the principal trees of the Chiltern woods. The undergrowth varies according to the trees with which it is associated. Farther north conifers appear more and more among the deciduous trees.

4. CONIFEROUS FORESTS. These cover huge areas in Scandinavia, as well as northern Russia, where they are called 'taiga'. In North America they are found in British Columbia on the Pacific coast, and they extend from the GREAT LAKES (q.v.) northwards into Canada. There are few types of trees, the main kinds being red pine, Douglas fir, and spruce. The trees grow to a good size and are used not only for timber but for wood-pulp for paper-making. Lumbering is a flourishing industry in coniferous forests, the huge trunks being often transported to the saw-mills by river. To replace the forests which are being felled, it is necessary to plant young

s to the new forests—a process called ...estation.

...so Vol. II: ...oodlands.

... also Vol. VI: Forestry, Trees, Broad-leaved, ... Conifers.

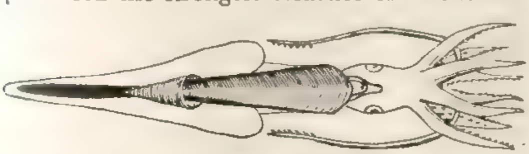
)RMOSA (Taiwan), once Japanese, was ...rned to China in 1945. It lies across the ...pic of Cancer in the Pacific Ocean, separated ... south-east China by the Strait of Formosa ...Map, p. 87). It makes a good stepping-stone ...een Japan and the Philippine Islands. It is ...st 230 miles long from north to south, and ... 80 miles broad.

...ligh mountains run its whole length, the ...st peak, Mount Morrison, reaching 14,700 ... above sea-level. Eastward the mountains ... steeply, in some places in sheer cliffs, to the ...fic. Westward they fall by hills and plateaux ...rtile plains. Much of the high mountain ...try is covered with thick rich forest which ...udes camphor, oak, cypress, and cedar trees, ... in which bears, wild pigs, and deer are ...tiful. Terraced rice-fields cover most of the ...t, and sugar, tea, tobacco, ground-nuts, soya-...ns, hemp, jute, bananas, and pine-apples are ... grown in quantity. There is some mineral ... metal wealth, including gold, silver, coal, ...er, and petroleum.

...he capital is Taihoku (or Taipoh). It is at ... north end of the island, and is a well-...igned city of broad streets, parks, and fine ...ldings. Formosa is densely populated—it has ...ut 7,600,000 people.

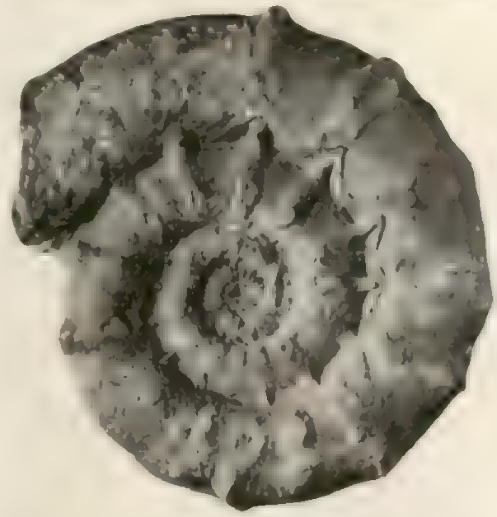
...e also Japan.

FOSSILS (Lat. *fossus*, something dug up). A fossil is either the remains of any animal or plant preserved in rock and petrified or turned to stone, or it is the petrified cast or impression left by the buried animal or plant after it itself has decomposed. The study of fossils, which is known as 'palaeontology' (Gk. *palaios*, old), has produced the strongest evidence of Evolution



A BELEMNITE
This creature belonged to the same family as cuttle fishes and octopuses. The fossilized end of the shell (shown black) is the part which is most often found
After H. Woods, 'Palaeontology', C.U.P.

(q.v. Vol. II), that is to say, of the gradual changes of animal and plant types over immensely long periods of time, and has also made it possible for geologists to work out a time order and approximate ages for Rocks (q.v.). Those most typical of each stage in the history of the earth are listed in the article Earth, History of.



AN AMMONITE
These fossils vary from a few inches to over two feet across
Dr. W. J. Arkell

Millions of different fossils have been found in the rocks of the earth; but even these are only a small proportion of the myriad types of life that have existed in past times, because special conditions are required for the preservation of animal or plant remains. To see why this is so we must consider the conditions under which the remains of animals or plants are preserved to-day, since in geology the key to the past is the present.

We know that a dead animal does not remain long on the earth's surface: scavengers such as jackals, crows, fly-maggots, earthworms, and germs soon leave only the bones. Then sun and frost, wind and rain, stream and river proceed to turn even the bones to dust. Much the same happens to the dead plant. Indeed, unless the body of the animal or plant is buried in the sand of a dry desert, or preserved in the ice of a frozen waste, or covered by sand or mud in a pond, or sinks to the bottom of the sea, it is not likely to become fossilized. And so most fossils are of plants and animals that lived in water, fresh or salt, or by the water's edge. Animals with a hard outer skeleton sink to the sea bottom when they

FOSSIL OF AN ICHTHYOSAURUS (FISH-LIZARD) EMBEDDED IN STONE
University Museum, Oxford

die, and are most likely to become fossils. Some animals actually live on the sea bottom, such as shell-fish of all kinds, including crabs, lobsters, sea-urchins, sea-lilies (which are animals, not plants), and so did shell animals of long ago such as ammonites and trilobites.

Fishes do not normally become fossilized, for dead fish do not sink; so fossil fish are quite rare and can have been formed only when the dead animal was covered quickly by sand or mud—as on the shore between tides, or in unusual conditions such as an invasion of fresh water by sea-water, in which the fresh-water fish drown. (This happened on a large scale at the end of the Triassic Age some 150 millions of years ago.)

An explosion in or near the water can also kill fish in large numbers. In the Old Red Sandstone of Fife have been found fossils of shoals of fish, the presence of which was difficult to explain until it was discovered that there had been volcanoes near the coast. A tidal wave, which often follows a great volcanic outburst or earthquake, may well have carried the fish on to dry land. If a sand-storm followed—and the red sand indicates that it was a desert area—the fish would have been buried in conditions likely to fossilize them. Some fish that died in a less spectacular way became partially fossilized. These were fish that had very hard large teeth, or scales so thick that they have been called armoured fish. The teeth of sharks, for instance, are so strong that they are nearly always preserved. They sink to the bottom of the deepest oceans, and recent additions are found lying side by side in the 'red clay' with the teeth of sharks that died millions of years ago (*see* Ooz[illegible]

The teeth of land animals, and of man, too, are often preserved when little else remains (*see* FOSSIL MAN, Vol. I). In the gravel terraces of the River Thames teeth are found of the mammoth and of the smaller elephant that roamed over England in the warm intervals of the Ice Ages. It was probably a fossil elephant tooth that was mistaken in the 18th century for that of 'a giant of prodigious bigness'. But even this guess was less absurd than some early suggestions for the origin of fossils—as that they were shapes caused by lightning, or by the Devil, or were the remains of animals petrified by saints (*see* PREHISTORIC ANIMALS).

It is less surprising that hard things, like teeth, should be preserved through millions of years, than that animals and plants of the softest material should sometimes have left fossil marks. Yet occasionally we find the fossil imprint of a jelly-fish, thrown up perhaps on a sandy shore and covered with blown sand which has not been washed away. Even the fossil impressions of raindrops on a sandy shore are not very rare, and fossil mudcracks are well known.

Soft plants, too, such as seaweeds, have left impressions in sand and mud with sufficient detail for scientists to classify them. The fossil was made in this way: the buried seaweed in course of time decomposed or rotted away, leaving a mould in the rock, which often became filled with mineral matter, introduced in solution

·· water. The mineral hardened into rock, ereby preserving the original impression of the aweed. Plants with harder structures, such as : trunks and roots of trees, have left more in e way of fossils (*see* COAL). The seed cases and rd fruits of plants fossilize well. For instance, palm fruits found in the London Clay are so ll preserved that it is clear they come from ree almost exactly like a tropical palm which common to-day in the brackish estuaries of lia, Malaya, and Australia. And this allows to tell the climate of that time. Even leaves ke good fossils when they fall on soft mud, d many fossil leaves have been found, showing arly their veins and general structure.

ee also EARTH, HISTORY OF; ROCKS, Section 3; ICE ; PREHISTORIC ANIMALS.

RANCE. On a fine day the coast of France, ly some 20 miles away, can be seen from some rts of southern England. France has a most lvantageous position, for she has harbours on Atlantic Ocean and on the Mediterranean a, has easy access by her English Channel rts to the North Sea, and she is at the western d of land routes across Europe from the east d south-east. Though Mont Blanc, the highest untain in Europe, is within the borders France, yet more than half of the country less than 650 feet above sea-level; and this

FRANCE

MONT BLANC

flatness and the broad courses of her big rivers have led to the making of many canals, and, as a result, to an abundance of cheap transport. For every 4 miles of railway there is one of water-way.

France can be divided roughly into a low-lying north and west and a hilly or mountainous east and south. The mountains of the east and south form in general good natural frontiers. The boundary between France and Spain follows the crest of the precipitous north slopes of the PYRENEES (q.v.), whose forested heights are crossed by no easy passes. On the south-east, the French Alps are divided from the high plateau of south-east France by the valley of the River Rhône, which rises in an Alpine glacier, flows through Lake Geneva, joins the River Saône, and flows into the Gulf of Lyons near Marseilles. The French Alps are part of the Alps of Switzerland and Italy, and the frontiers twist along their heights. They rise steeply above the Rhône valley, and many of their streams are harnessed to produce hydro-electric power for industry and for railways. The Jura Mountains, which continue the Alps northwards, are similar in character, but not so high. The Belfort Gap makes a passage between the Jura and the Vosges Mountains, which fall steeply to the Rhine rift valley on the east (*see* RHINE). West of the Vosges lies the plateau of Lorraine, an

CHÂTEAU OF LE ROCHEPOT, BURGUNDY
Miss D. Carroll

infertile but often thickly forested area, which holds great wealth in its coal and iron-mines, and has been heavily industrialized. Nancy, its chief town, is an iron-smelting and cotton-manufacturing centre.

To the east of Lorraine, Alsace stretches down to the Rhine, mainly an agricultural region, but with very valuable potash-mines. Alsace-Lorraine is important not only for its mineral and industrial wealth, but also because of its strategic position across important routes between France and Germany. The district has therefore been fiercely contended for between the two great powers, and has changed hands several times. Verdun on the Meuse and Metz on the Moselle are both fortress towns. The most important town of this whole region is the ancient city of Strasbourg, a big river port on a tributary of the Rhine. Farther north, the hilly, wooded country of the Ardennes continues into Luxembourg and Belgium, and then low plains stretch to the sea.

The Central Plateau of south-east France is the only other mountain area. It lies west of the Rhône valley, and is separated from the Pyrenees by the valleys of the Garonne and the Aude. These valleys form an easy route from the Mediterranean to the lowlands of north-west France—a route guarded by the magnificent fortified medieval city, Carcassonne. The scenery is very varied, because it is made of many different kinds of rock. In the north there is a wide plateau of poor soil, where sheep and cattle are reared. In the centre the cones of old volcanoes rise abruptly in precipitous peaks above fairly rich rolling country, which is excellent pasture for dairy cattle. In the southern part of the Plateau there are great areas of limestone known as the Causses, cut by deep gorges and by underground streams and CAVES (q.v.). Sheep are pastured on the short grass which covers much of the limestone areas, and sheep's-milk cheeses are exported.

The great Rhône valley is important as a north–south routeway, with branches leading north-west to Paris, north-eastward by the Belfort Gap to the Rhine Valley at Basle, and east to Switzerland and Italy. It is very highly cultivated: vines and early vegetables are grown everywhere, and olives and mulberry trees are cultivated in the south.

The Mediterranean lowlands continue the cultivation of the Rhône valley. MARSEILLES (q.v.), the chief port of France, near the mouth of the Rhône, is the port for both regions. East of Marseilles lies a narrow, sheltered, coastal plain, backed by the steeply rising forested slopes of the Alps. This coast has so mild a climate and such magnificent scenery that it has become a world-famous holidaying place. It carries the lovely name of Côte d'Azur (sky-blue coast), and is known to holiday-makers as the Riviera. A few miles from the Italian border is the small independent principality of Monaco, about 3 miles long and $1\frac{1}{2}$ miles deep. The old town of Monaco is built on a rock jutting out into the Mediterranean. Adjoining it is Monte Carlo, famous for its casino.

West of the Central Plateau the Pyrenees fall, at first steeply, and then in long, much-gullied fans, to the south-western lowlands watered by the Garonne and its tributaries. On the Garonne estuary stands the city of Bordeaux. South of the estuary is a sandy coastal district, which has been drained and planted with pines, from which timber, resin, and turpentine are obtained. The area round the estuary is famous for its wines and brandy.

In north central France lies the Paris Basin, the heart of France. Paris itself lies in the centre

MARTIGUES, A FISHING VILLAGE ON THE MEDITERRANEAN. *C. H. Gough*

vhat can be likened to a nest of saucers, each ing in gentle slopes away from the centre, to ll by steep chalk or limestone escarpments to larger saucer below. The English Channel eaks the northern side of the circular shape of e Basin. The gentle slopes vary in soil and in rtility: some are well-drained wheatlands, hers are pasture. A few of the valleys which ut through the region are wide and marshy, nd the Somme marshes have been reclaimed or market gardening. The French part of the Franco-Belgian coal-field is in the north-east of the Paris Basin, and therefore many big manufacturing towns, such as Lille and Roubaix, have grown up, and these export their goods through Havre, the second largest port in France. PARIS (q.v.) on the River Seine, is a road, rail, canal, and air centre, as well as a great cultural and industrial town.

In the north, Normandy is an apple-growing and cattle-farming region, and Brittany is an upland region of moor and forest with small areas of not very fertile soil, on which rye and oats are grown. The coast-lands are more fertile, and grow flowers, early vegetables, and early fruits, mainly for the Paris market. All along the coast of Brittany are many flourishing fishing ports.

South-west of the Paris Basin, the River Loire cuts a broad fertile valley across an area of woods and moor. The Loire is a difficult river, for it alternates between flood seasons, which bring down large amounts of coarse sand, and spells of very low water. Many tourists visit the district to see the lovely Renaissance castles, often magnificently situated above the banks of the river. At the mouth of the Loire are Nantes and the naval port of Saint-Nazaire.

The climate of France varies as much as its scenery. In the north-west it is very like that of southern England. In the south there is a true Mediterranean climate with no rain in summer. On the high French Alps snow lies all year. It has been said that French people rarely take holidays abroad; for, indeed, within their own country they have a sufficient diversity of scenery and climate to suit all tastes.

The chief occupation of the French is farming. There are large areas of wheatland and some maize; barley is cultivated in the north, and hardier grains such as oats and rye in the poorer land of Brittany and the Central Plateau. Flax

and sugar-beet are grown in the northern plains and potatoes are widely cultivated. The most famous crop is the vine, which flourishes nearly everywhere except in the north. Mediterranean France grows olives and mulberries for silk-worms. The oil from the olives, extracted in the factories of Marseilles, is used, among other things, for soap and fish-canning industries. In the past the silk mills of Lyons depended on local silk, but now they use imported raw silk. The mild, sheltered country of the Riviera is terraced to grow oranges, palms, gum-trees, and exotic flowers. Very much French farming is still carried on in small peasant holdings, and the French people are very deeply attached to the soil.

The most important mineral asset of France is the Lorraine iron-field. Its output, together with that of the mines south of Caen in Normandy, is more than four times that of Great Britain. Coal, however, has to be imported. Many hydro-electric plants have been constructed in the French Alps, the Pyrenees, the Jura Mountains, and the Central Plateau to help to offset the shortage of coal. The principal industrial district in north-west France has cotton, woollen, and linen factories, as well as the heavy industries of iron and steel. The industries of Paris include motor-cars, furniture, clothes, and luxury goods, while the gloves of Grenoble and the china of Sèvres and of Limoges are world famous.

See also Vol. I: French.

FRANKFURT-ON-MAIN. This city, not to be confused with the smaller Frankfurt on the Oder, east of Berlin, used to be the most important town in Germany, and may well become of great importance in the future. It has a very good geographical position, on the River Main 20 miles above its junction with the Rhine. From this point four valleys radiate, giving access to the four quarters of Germany—to Prussia in the north, to southern Germany and Switzerland, to France in the west, and eastwards up the Main to Bavaria and then down the Danube to the Balkans. It is not surprising that by the 20th century it was a rich and noble commercial town of some half a million inhabitants. It had gigantic industrial plants, producing chemicals, dyes, and drugs, as well as motor-cars, bicycles, and many other goods. The famous banking-house of Rothschild (q.v. Vol. V) originated here, and the city is still a great commercial centre, and, in particular, a money-market.

Frankfurt started as a Roman and then as a Frankish settlement: its name Frankfurt means 'Ford of the Franks'. In 794 the great Emperor Charlemagne (q.v. Vol. V) called the assembly of his Empire there, and from that time until 1806 the German Emperors were crowned in the Römer, the City Hall, of Frankfurt. In 1848–9 the seat of the first German national parliament was St. Paul's Church in Frankfurt. After the Second World War Frankfurt was selected to be the centre of the British and American Occupation Zones. Very many famous people have been connected with the city. Luther lived there; John Knox was pastor there for a period; Goethe, the greatest German poet, was born there; Gustavus Adolphus, Napoleon, and Bismarck all lived there at some time (qq.v. Vol. V).

The old centre of Frankfurt was very picturesque, with its Cathedral, City Hall, and many steep-roofed old buildings, among which was Goethe's house. A green belt, along the line of the old fortifications, divides the old city from the great residential and industrial suburbs of the new. But Frankfurt suffered very severely from bombing between 1940 and 19[illegible] and much of the beautiful old city was destroyed.

FRENCH AFRICA. Very large parts of North, West, and Central Africa (*see* Map, p. 5), as well as the large island of Madagascar (q.v.) off the east coast, are part of the French Empire, either as colonies or protectorates. French North Africa consists of the protectorates of French Morocco and Tunisia, and the large colony of Algeria (qq.v.). French West Africa is administered as one unit by a governor-general, with his headquarters at Dakar on the west coast. It is made up of Senegal, French Guinea, Ivory Coast, French Togoland, and Dahomey (*see* Guinea Lands), and of Mauritania, French Sudan, and Niger Colony (*see* Sudan). French Equatorial Africa, sometimes known as French Congo, is a group name for French Cameroons, Gabon, and Middle Congo (*see* Guinea Lands), and Ubangi-Shari and Chad Territory (*see* Sudan).

FROST is the condition of the atmosphere at 32° F. (or 0° C.) and below, at which temperature ice begins to form. The word is used also to describe the work of frost—the crystals which

m on window-panes in intensely cold weather, he white crystallization of water-vapour that rs the grass in winter. We use the word also n we speak of a long period of bitter weather ing which the temperature remains below ing-point, as in the great frosts of 1895 and .

ost is most in evidence in polar or in high ntain regions, where there is permanent ice. e British Isles the average winter tempera- is everywhere above 36° F. except on very ground, though frosts are not uncommon, during a hard winter sometimes last for ks or even months.

The factors which favour frosty conditions in perate regions are: the spreading of a cold mass', either from polar or continental ons (*see* WEATHER); clear skies, which allow d radiation of heat from the ground; and nce of wind, which would blow the cool r layer of air away. In such conditions, with fairly dry (since heavy moisture slows up iation), frost is probable at night even with evening temperature of 40–5°.

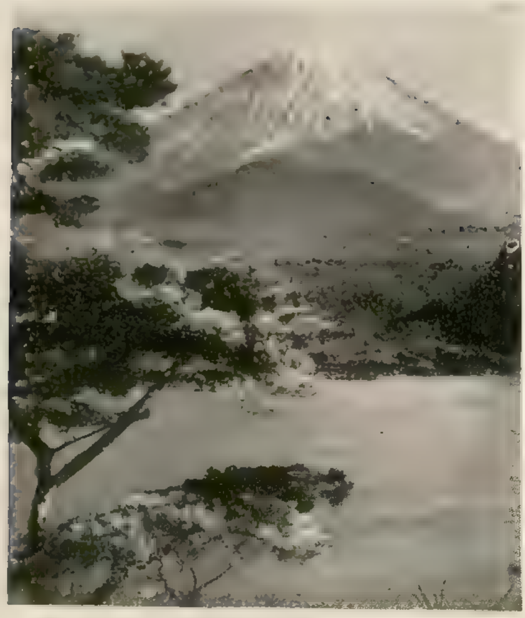
The probability of night frost depends very uch on the exact position of a place. When a r of very cold (and therefore heavy) air vers the ground on a windless night, it tends flow downhill and collect in the dips and lleys, just as water might do. Wise fruit- ners, therefore, who wish to protect their ossom against frost, avoid planting their trees such places—or, if they are already growing ere, guard against frost on likely nights by lighting fires. It is not the heat of these fires which gives the protection, but the way in which the hot air rises and so stirs up the air all around. In mountainous countries, these descending flows of icy air may rush down into the valleys like gales—reaching in Greenland speeds of up to 100 miles an hour.

The commonest type of frost is probably 'hoar-frost'. This is not exactly frozen DEW (q.v.) as is popularly supposed, since with hoar-frost the water-vapour condenses straight into ice, without ever becoming liquid. The ice crystals form on solid objects such as grass, twigs, leaves, house roofs, and even spiders' webs. These crystals are lovely to look at, resembling tiny ferns, and there are few things more beautiful than a country-side sparkling with frost under the morning sun. Sometimes the leaves are fringed with small grains called 'rime'. This granular form of white frost is formed by the water-vapour condensing into minute droplets of FOG (q.v.) and then coming into contact with cold objects, which freeze them. Spectacular effects of frost are often to be found on window-panes, where a delicate tracery forms on the inner side. This is due to the moisture in the room crystallizing on the cold dry pane.

In contrast to the fairyland produced by hoar-frost, there is the cold iron-like rigidity of the ground during a 'black frost', when there are no white crystals except in sheltered positions behind hedges or large tufts of grass. This is no local chilling of the air at ground-level, but shows the presence over the country of a great mass of air whose temperature is below freezing-point. Consequently, the icy winds it often brings tend to increase rather than lessen its severity. Such conditions are usually due to a flow of air from the frozen, snow-covered Continent during an anticyclone. They give us our longest periods of frost.

In the days before the Thames at London became a busy waterway, black frosts occasionally froze the river over, turning it into a road on which great Frost Fairs were held with tents and booths, where shopkeepers sold their wares to the hundreds of pleasure-seekers, and oxen were roasted whole over great fires. During the winter of 1683 the river was frozen over for two months, and horse-racing took place on the ice. In more recent times there have been occasions when the river was partially frozen, as in February 1917, but many factors now combine to prevent this, such as the warmth given out by the many buildings, and the 'blanket' effect of the smoke, which slows up the loss of heat by radiation.

A 'silver thaw' or glazed frost happens when a layer of warm air lies above air which is nearer the ground and below freezing-point. If rain then falls through the cold air, the drops become super-cooled and, directly they come into contact with a solid, begin to freeze, covering everything with a coating of ice. In such circumstances telegraph-wires and even twigs may become coated with ice as thick as one's wrist, until the sheer weight cannot be borne, and they break. A slight glazed frost occurs most winters, but, during the severe weather of January 1940, there occurred a quite exceptional glazed frost, which caused severe damage to trees in many parts of the British Isles. Luckily, such conditions do not often occur in this country.



FUJIYAMA. *Paul Popper*

FUJIYAMA. One of the most famous of the world's volcanoes is Mount Fuji, in north-eastern Japan, about 70 miles from the capital, Tokyo. It is 12,365 feet high—the highest mountain in Japan. The last time that Fuji had an eruption was in 1707. But the fires in its heart may be only sleeping, for steam still comes out of some of the cracks round the lip of its crater. There are many natural hot springs in the valleys round its base.

Fuji stands alone, sloping down to the sea on one side and surrounded on the other sides by lesser mountains, by forests and open country, and by a string of beautiful lakes. Strangers coming to Japan through the port of Yokohama are greeted by the sight of Fuji, rising from the clouds, when no other land is visible. Home-sick Japanese, leaving their country, crowd to the stern of their ship, looking at their sacred mountain to the last. Fuji seems to stand at one end of almost every street in the huge, noisy, rambling city of TOKYO (q.v.), seen through a maze of telegraph-wires or over temple roofs.

Even in the height of summer Fuji is crowned with snow, though in the hottest days the snow crown is rather streaky. In winter the whole mountain is covered with snow. In the flattened top is the great crater, 2,000 feet across and about 600 feet deep. The sides and floor of the crater are covered with loose cinders and jagged lava rocks.

Every Japanese hopes at some time in his life to climb Mount Fuji and to watch the sunrise from the top. An expedition up Fuji—or up any other of Japan's many sacred mountains—is something between a holiday outing and a religious pilgrimage. Pilgrims wear white kimonos and broad-brimmed, rather flat, straw hats, and carry thick wooden staves. Those pilgrims who pride themselves on doing as many popular expeditions as possible have the names of each shrine they have been to stamped on their kimono. In old days no woman might climb Mount Fuji or any other sacred mountain. But women, even in Japan, now do many things that would have shocked their grandmothers

The first part of the climb up Fuji can be done on horseback. At Uma gaeshi—the name means 'where you must leave your horse', and there is a place of that name half-way up several other mountains—the pilgrim must take to his feet. Ten hours are usually given for the climb. The wise pilgrim arranges to sleep at one of the rest-houses on the higher slopes of the mountain, getting to the top in time to see the sunrise, and then to watch the whole immense view of the sea and land, mountain and valley, break out of the clouds of dawn.

Japanese call their mountain Fuji San or Fuji Yama. Both *San* and *Yama* mean 'mountain' and are written with the same character or little picture. They call her 'O Yama', which means 'the Honourable Mountain', and say she is like a half-opened fan held down from Heaven. Every Japanese poet has written of Fuji. Every artist has painted her. One famous artist, called Hokusai, painted a series of 'One Hundred Views of Mount Fuji'. Fuji appears on china teapots, lacquer boxes, woven into rich brocade or cotton towels, decorating huge advertisement posters, or stamped on to cakes. The boughs of trees are bent, with wedges, to make them grow into a Fuji shape. Japanese cooks make what they would call a 'foreign style' pudding of chocolate and white cream, which is a copy of the mountain. But none of these things can spoil Mount Fuji. It remains one of the outstanding beauties of the world.

See also JAPAN; VOLCANOES.

G

AXY, *see* Universe.

MBIA. The British Crown Colony and Pro-rate of Gambia in West Africa is only a ow strip of country running inland on both of the River Gambia for some 300 miles its mouth (*see* Map, p. 5). For about 70 from the coast the territory is about 30 wide; farther inland it is only about les wide. It has a population of about ,000.

he Gambia is a large river, emptying into the ntic on the westernmost bulge of Africa. s of 8,000 tons can navigate it for 150 miles the sea; and 100 miles farther upstream it ill tidal, as wide as the Thames at London dge, and, in flood time, capable of rising more 40 feet. Swamps border most of its lower ches, though increasing areas are being re-imed for rice land. Most of the villages are ay from the river, on higher and drier land, ere a primitive agriculture is practised on soil which is poor and sandy. However, about every 10 miles along the Gambia there is a wharf town, where ground-nuts, the chief crop, are collected for export and where European goods, mainly cotton, can be bought. Little river steamers and tugs call at these trading centres, and a certain amount of traffic is carried by sailing-ship and by dug-out canoe. Most of the people travel on foot along bush paths, transporting their produce on donkeys.

A NATIVE VILLAGE IN GAMBIA
Royal Mail Lines

Ten miles up the river there is a sand-bank which was fortified by the British in 1816 in their efforts to end the Slave Trade. Bathurst, the seat of British administration, is built on this island. A bridge connects it to the mainland.

The Gambia abounds in hippopotamuses and crocodiles. Lions are few in number; but there are many leopards, hyenas, monkeys, baboons, and chimpanzees. In the rainy season, from May to October, there are swarms of mosquitoes, and in some areas there are tsetse-flies. Plagues of locusts occasionally ravage the land and devour the crops.

See also Guinea Lands.

GANGES. The Ganges issues from an ice cave in the south face of the Himalayas (q.v.) at an altitude of 10,000 feet. Flowing generally southwards, it cuts through the mountains as a series of long, deep pools separated by shoals and rapids, which are flooded during the rainy season and the period of melting snow. From a point 70 miles east of Delhi it flows south-east to Allahabad, where it is joined by its chief tributary, the Jumna. The Jumna also rises in the Himalayas, but west of the Ganges, and follows a roughly parallel course, passing through Delhi (q.v.) and Agra. The Ganges and Jumna are the main streams of a vast river system which drains the high ground surrounding the upper part of the great Indo-Gangetic Plain (*see* India, Map, p. 229) on the north, west, and south. This system is supplemented in places by canals which extend the watered area over a wide part of the plain.

From Allahabad the Ganges, by this time a mighty river, flows eastwards for over 400 miles, receiving water from the Himalayas by tributaries such as the Gogra and Rapti, and from the peninsular plateau by rivers such as the Son, which joins the main stream at Patna. The greater volume of the tributaries from the

A BOAT ON THE GANGES. *R. Gorbold*

northern side causes the river to flow along the southern part of the plain.

The Ganges spreads silt over its flood plain, making it one of the most fertile and productive regions of the world. The peasant population is spread over the plain in thousands of villages, and towns such as Lucknow, Cawnpore, and Benares, are situated near the main river. To the Hindus the Ganges is a holy river. Shrines are found all along it; but the most famous are at Benares, where hundreds of thousands of pilgrims come each year to bathe in the holy waters.

At the eastern edge of the peninsular plateau the river enters Bengal and turns south. Two hundred and twenty miles from the sea it begins to spread out in a great delta, which covers part of Bengal with a network of sluggish streams. Boats are the chief form of transport here. The main outlet to the sea is called the River Hooghly. A tidal bore sweeps up the Hooghly each day from the Bay of Bengal, and keeps its channel clear for shipping up to the port of CALCUTTA (q.v.). A large number of marshy islands, called the Sundarbans, covered at high tide, are formed by the delta at its seaward end. These islands are covered with mangrove swamp and are uninhabitable.

In its lower reaches the Ganges is continually changing its course and forming sand-banks which are dangerous to shipping. Buildings too near its banks are often swept away in floods.

See also RIVERS; INDIA.
See also Vol. I: HINDUISM.

GARNET. All garnets have originally been crystals of cubic shape, though those found in gravels have often been worn to rounded pebbles. Several kinds are not pretty enough for use in jewellery. Among those ranked as gems are stones ranging in colour from golden-yellow to cinnamon-brown, known as hessonite garnet. They come mainly from Ceylon and Brazil. Deep red or Bohemian garnets are the most commonly used, though they are too common to be really 'precious'. Sometimes they are known as Cape rubies or Arizona rubies. Colorado and Arizona in the U.S.A., Rhodesia, South Africa, and Brazil produce them; but Bohemia supplies the greatest number and has done so for many centuries.

Another gem garnet is deep purplish-red, and is called a 'carbuncle' when cut in a certain way. It comes mainly from Brazil and Ceylon.

A softer form of gem garnet is olivine garnet, or demantoid garnet. The best specimens are bright green in colour and come from the Ural Mountains of the U.S.S.R. They have greater 'fire'—as the power to break up white light is called—than any other stone, even a diamond; but this is hidden by their colour. When cut they have a brilliant lustre.

GAS, NATURAL. This term is generally used to describe the gas often present with deposits of petroleum (*see* OIL, NATURAL). Such gas issues from the ground in many parts of the world—in the Caucasian oil-field, in China, but most of all in North America, where Chicago, Pittsburgh, and other towns are supplied with natural gas pumped to them, if necessary from over a hundred miles away. In England the railway station at Heathfield in Sussex used to be lighted in this way.

As the gas found with petroleum (on top of which it accumulates) has been formed from the same substance—the remains of minute animal and plant life deposited at the bottom of salt water millions of years ago—as the oil itself, it is not surprising that it consists mainly of 'marsh gas' (or methane) which, as its name implies, is

n off by marshes and swamps, and is also a t of decaying organic matter. The 'fire-' dreaded by miners in coal-workings is iarsh gas, mixed with enough air to make it sive—and here, too, its origin can be traced decomposition of organic material—the pre-'c trees and ferns that are now COAL (q.v.). rsh gas is, of course, by no means the only nitted from the surface of the earth. The on of VOLCANOES (q.v.) is usually accom-d by the emission of enormous volumes of and vapours of many kinds; but even when lcanoes have been inactive for centuries, iot unusual in their neighbourhood for gas continuously discharged from certain vents e ground. A famous example is the Grotta ane (or Cave of Dogs) near Naples, where n beings can breathe safely owing to their it, but dogs are quickly made unconscious he heavy layer of carbonic acid gas (carbon de) hanging near the floor. The Valley of h in Java and Death Gulch in the Yellow-Park, U.S.A., perpetuate in their names tragic episodes. There is an old legend that prophetess of the famous Delphic Oracle of ient Greece owed her inspiration to breath-mystic vapour that rose from a cleft in the , the effect of which was to reduce her to ulsions, when the god Apollo would make of her to deliver his messages to mankind DIVINATION, Vol. I). Though we may think t the seizures were probably caused by the rel leaves which she chewed before awaiting iration, the fact that the god is said to have fended his shrine by earthquakes which hurled down rocks against the invaders in 480 and again 279 B.C. suggests that there was at that time volcanic activity which might well have been accompanied by the emission of gas.

See also Vol. VII: GAS INDUSTRY.

GENEVA (Pop. 145,000). The town of Geneva lies at the south-west end of Lake Geneva. It is the capital of the tiny Swiss Canton of Geneva, which is almost surrounded on its landward side by France. Geneva was a town even in Roman days. At one time it was part of Burgundy, but in the 16th century its citizens made an alliance with the Swiss Cantons of Bern and Fribourg and with their help became independent. Geneva joined the Swiss Confederation in 1814.

Geneva is a mixture of old and new. The Cathedral dates from the 12th century, and there are fine examples of 15th to 18th century architecture, as well as big modern squares and boulevards and many magnificent public buildings. The blue waters of the River Rhône rush out of the lake and through the town, and are joined by the grey snow-waters of the River Arve. Both rivers are crossed by a number of fine bridges.

Geneva has always been more a European than a purely Swiss city. In the 16th century Calvin, the French religious reformer, lived and worked there for a long time, and it became the centre of what was later called CALVINISM (q.v., Vol. I). It was chosen for the international conference of 1864, the Geneva Convention, at which the rules for taking care of sick and wounded in war-time were drawn up. After the World War of 1914–18 it was agreed that the headquarters of the newly formed LEAGUE OF NATIONS (q.v., Vol. X) and of the International Labour Office should be in Geneva. The International Labour Office building was in use by 1926; but the Palace of the League of Nations was still unfinished when the Second World War broke out in 1939.

It is a commercial and industrial town, too, and is important for the manufacture of watches, and scientific instruments, cutlery, and jewellery.

See also SWITZERLAND.

GENOA (GENOVA) is on the north-west coast of Italy and is its most important seaport, with a population of over 680,000. It serves as passenger and cargo port for most of northern Italy, including the big industrial towns of MILAN (q.v.) and Turin. Its extensive shipbuilding yards, the docks, and parts of the city were badly damaged by air attacks in the Second World War. Genoa is built on a narrow coastal plain and stretches up the slopes of the hills behind, so that some of the streets are very steep, and funiculars are used to reach the upper parts of the town. It has a surprisingly rigorous climate, to which has been attributed the energy and toughness of the Genoese, who have been famous for centuries as merchant adventurers, warriors, and sailors. Christopher COLUMBUS (q.v., Vol. V), for instance, is reputed to have been a Genoese. During the Middle Ages Genoa ranked as a first-class sea power, a rival to VENICE (q.v.). She established scattered colonies throughout the Middle East and as far afield as the Crimea, and imported to Europe the luxuries of the East. But she wasted her

resources by wars with her rivals, especially Venice, and, during peace-time, by internal quarrels and civil strife. By the 17th century the Turks had captured her colonies, and Genoa had given place as a sea power to France, Great Britain, and Holland. In 1870 Genoa became part of the united Kingdom of Italy. One of her citizens, Giuseppe Mazzini (q.v., Vol. V), played an important part in bringing about this unification.

Genoa is a fine town and bears traces of past greatness in her many impressive palaces and beautiful medieval churches; while the number of modern buildings leaves no doubt as to her present vitality. A famous curiosity is the large cemetery with its extravagant marble monuments.

See also Italy.

GEOLOGY. This is the study of the earth (Greek *geo*, earth, and *logos*, study). Since little study can be made of the earth's interior, save from the evidence of earthquakes and volcanoes and from the known mass of the earth, geology has to deal mainly with the solid 'crust' of the earth. This varies in thickness, but may be regarded as having an average thickness of 20 miles. Below this lies the 'sub-crust', which is believed to be in a semi-plastic condition, owing to the increase of temperature as greater depths are penetrated, and also to the fact that the lightest and least easily melted substances are concentrated in the crust itself. If one part of the crust becomes heavier than another, the plastic sub-crust tends to be squeezed away from under this region and to thrust upwards below any adjacent region where the crust is not so heavy. These movements of the earth's crust, continued over thousands and even millions of years, help us to explain how layers of rock containing the remains of animals and plants which once lived in the sea are to be found on land at considerable distances from the sea-shores of to-day.

As well as studying the processes which go to make mountains and change the distribution of land and sea, geology is also concerned with the wearing away of the rocks and the deposition of sediments in the sea, since these processes affect the weight of the crust and its pressure on the sub-crust. These matters are also the concern of geographers; and thus the study of the action of air, wind, rain, rivers, frost, and ice upon the earth's surface is common ground to both sciences, and is sometimes known as 'physiography'.

Another branch of geology, known as 'stratigraphy', is a detailed study of the strata or layers of rock of which the earth is composed. Not all the crust, however, is to be found in layers, for some of it has been formed from molten rocks from the earth's sub-crust. The science of stratigraphy springs from the work of William Smith (1769–1839), sometimes called 'the father of geology'. He first convinced people that, in a series of layers of rock, unless we can prove that these layers have been overturned, the bottom layer is the oldest. This principle, which now seems to us fairly obvious, is sometimes called the 'First Law of Stratigraphy', and is of great importance to geology, the whole science of which is built up on the assumption that the present provides many clues to the past. It follows from these principles that any animals or plants whose remains are found in lower beds of unturned strata must have existed before animals or plants whose remains are found in beds lying above. Such remains are called Fossils (q.v.), from the Latin word *fossus*, 'something dug up' (*see* Archaeology, Vol. I).

William Smith further suggested that rocks which contain exactly the same types of fossil were probably formed at approximately the same time. This is called the Second Law of Stratigraphy. Many years of detailed and exhaustive investigation all over the world have conclusively proved it to be correct. The period

SECTION ACROSS ENGLAND FROM THE MALVERN HILLS TO THE CHILTERN HILLS

1. Pre-Cambrian and Cambrian
2. Triassic
3. Lias
4. Lower Oolites
5. Oxford Clay
6. Corallian
7. Kimeridge Clay
8. Portland Beds
9. Gault and Upper Greensand
10. Chalk

From A. Holmes, 'Principles of Physical Geology', Nelson

...mation of any rock can be determined by ...l content, if it has any. For it has been ...that although some types of fossil may be ...in beds of great age and also in beds which ...een formed comparatively recently, there ...ers which are to be found only in one ...m—some being restricted to no more than ...feet of the bed, or even less. From these ...of restricted range we can tell the age of ...k—and so the finding of them is one ...chief tasks of the geologist. The study ...ls is known as palaeontology (Gk. *pa-* ...ncient); and in the universities and in the ...government museums of the world, in ...boratories of oil companies and mines, ...ists spend their whole time at this work ...ven so, are able to cover only a very small ...n of the field—in fact some men concen-... all their efforts on just one class of animal ...nt. In order to identify the fragments of ...ls and plants that he finds, and suggest ...part they may have played in the living ...ism, the geologist also has to study biology. ...ddition to palaeontology there is another ...h of geology, known as 'petrology' (Gk. ...stone), or the study of rocks. To the ...ogist the most interesting rocks on the ...are not those with fossils in them, but ...formed from the lavas which welled up ...r through the crust of the earth and have ...cooled either below or above the earth's ...ce. This very detailed study of rock con-...uents involves the use of the microscope, by m...ans of which the crystal and other contents of very thin sections, about a hundredth of an inch thick, are identified. It also requires an elementary knowledge of 'crystallography', which is the study of the origin, growth, physical properties, and even the internal molecular arrangement of crystals. Two further branches of geology are 'volcanology', the study of VOLCANOES (q.v.) and 'seismology' (Gk. *seismos*, earthquake), the study of EARTHQUAKES (q.v.). So geology involves a wide knowledge of the sciences, including physics and even ASTRONOMY (q.v.).

One of the main difficulties in writing about geology is that theories change from time to time. With almost any theory it is always possible that new evidence may come to light which does not fit—and then the theory must be altered. Secondly, there is the danger that the reader may confuse theory with fact—and it must be remembered that nature is not uniform and does not readily fit in with the rules and regulations or 'laws' with which men seek to describe natural processes. So in geology there are a number of minor facts which do not appear to fit in with existing theories. This may be because local variations from general principles are always possible, or that the facts do not tell the whole story so that other data should be sought to make quite sure that these facts and the main theory are actually in conflict. The geologist, therefore, cannot be dogmatic, but must be ready to modify his theories as new evidence shows the way.

See also EARTH; EARTH, HISTORY OF; MOUNTAIN BUILDING; CONTINENTAL DRIFT; DENUDATION; ROCKS; ROCK FORMATION; MINERALS.

GEORGIA, *see* UNITED STATES OF AMERICA.

GEORGIA. The Soviet Socialist Republic of Georgia, with a population of over $3\frac{1}{2}$ millions, is the western part of Transcaucasia, the southern end of the neck of land between the Black Sea and the Caspian Sea (*see* Map, p. 459). To the south-east are the Soviet Socialist Republics of ARMENIA (q.v.) and AZERBAIJAN (q.v.). Georgia is made up of the valley of the River Rion and a narrow coastal plain along the Black Sea, with mountain ranges, part of the CAUCASUS MOUNTAINS (q.v.), on the north and south.

A MINE IN THE UPPER RION VALLEY, GEORGIA
S.C.R.

The climate is sub-tropical, with mild winters and hot summers. Except in the extreme east there is ample moisture. Palm-trees and eucalyptus-trees flourish. Large orchards of peaches and of citrus fruits cover the coastal plain and the lower Rion valley, and on the lower hill-slopes there are tea and tobacco plantations and vineyards. The upper hill-slopes are forested with mixed deciduous and coniferous forests. On the very fertile soil of the middle Rion valley are vineyards, orchards, grain fields, mulberry-trees, and rich pastures for dairy cattle. In the extreme east of Georgia lack of rain results in dry, treeless grassland in the upper Rion valley, with bare and stony hill-sides. This poor agricultural area is rich in oil, however.

The capital of Georgia, Tiflis (or Tbilisi), is situated in the dry barren eastern region. The old city has narrow, crooked streets and flat-roofed houses: the new city is very modern, with its broad streets, big buildings, and electric lights. The word 'Tbilisi', meaning 'warm springs', refers to the sulphur springs of the city which have been in use since early times. The mild dry winter climate has made Tiflis a popular winter health resort.

See also U.S.S.R.

GERMANY. **1.** The central position of Germany, open to the very different influences of western and eastern Europe, helps to explain its long political importance. It was not until 1871 that the whole of the country was united under one central government (*see* GERMANS, Vol. I). In south and west Germany, the northern edge of the Jura mountains, the Alps, and the high mountains of the Böhmer Wald (Bohemian Forest) and the Erz Gebirge form the frontiers with Switzerland, Austria, and Czechoslovakia, and the deep Rhine valley and Rhine highlands that with France and Belgium. North Germany, on the other hand, is part of the vast European plain which stretches continuously from northern France eastwards to Russia. Here there are no natural frontiers—and those with Holland, Denmark, and Poland have always been easily crossed in time of war. The eastern frontier, in particular, has always been subject to change, as all through history German settlers have pushed steadily eastwards, seeking more land. To-day, after the Second World War, the German-Polish frontier has receded westwards to a line along the lower River Oder and its tributary, the Neisse.

Germany has three outstanding physical characteristics. Firstly, there is a very obvious division between the flat northern plain and the mountains of the centre and south. Secondly, more than a quarter of Germany is forested, mainly with pine forests. Thirdly, Germany is a land of large and important rivers. Four of these flow north to the Baltic and North Seas: the Oder and the Elbe rise in the mountains of Czechoslovakia, the Weser rises in central Germany, and the RHINE (q.v.) rises in Switzerland. The fifth important river is the DANUBE (q.v.), which flows eastwards across south Germany to the Black Sea. All these rivers, especially the first four, are navigable for much of their length, and have always played an important part in German trade. Their valleys are ancient trade-routes between northern Europe and the south and east: roads and railways still follow them to-day, and pass through the old historical trading towns.

Germany can be divided into three main regions, North Germany, Central and West Germany, and South Germany.

2. NORTH GERMANY is a lowland, made up of level plains and gently-sloping hills rising to about 500 feet above sea-level. Its southern boundary is the central uplands—roughly the line Cologne, Hanover, Magdeburg, Leipzig, Breslau (now in Poland). Across it wide, sluggish, winding rivers, edged by low terraces, flow not many feet below the general level of the land.

Climatically, north Germany falls within the belt of westerly winds, and the western half of the lowland obtains its rain from the Atlantic cyclones. Winters are long and hard, and summers rather warm. The farther east, the more severe becomes the climate. In north-east Germany the rivers and the Baltic Sea freeze over in winter, so that water transport is at a standstill, and the Baltic ports, such as Stettin, become useless. In contrast, the summers are very hot, and most rain falls in this season, largely in the form of heavy thunder rain.

The northern lowland is the least developed and most thinly populated region of Germany, much of the land being infertile and badly drained. South of the alluvial estuaries and the sand-dune and lagoon coasts, the country consists largely of dry, sandy pine forest, scrubby

FOREST AND FIELDS IN CENTRAL GERMANY

hland, rough pasture, and patches of low, npy moorland. The forests are the source i important timber industry. Villages are and scattered. In the wetter west are low rs, with swampy areas of peat-bog and s, though many have been reclaimed for iculture. The farms are usually built of red k.

North-east of the Elbe, in SCHLESWIG-HOLSTEIN (q.v.) and Mecklenburg, although the gion is thinly settled, there is more farming. Sugar-beet, potatoes, and rye are grown, and there are often hedges round the fields—an unusual feature in Germany. The black-and-white Holstein cattle come from this area.

The broad rivers wind across the lowland in wide cultivated valleys, the villages lying on the better-drained terraces. At the heads of the river estuaries lie the great German ports and manufacturing cities, Emden, Bremen, HAMBURG (q.v.), and Stettin. Inland, the one great town is BERLIN (q.v.), capital of Germany since 1871, and the centre of the road and railway system of the whole country.

The southern edge of the northern lowland is quite different from the rest. A rich, fertile belt of land, from 5 to 30 miles wide, stretches from Hanover to the Polish frontier, and is one of the most important agricultural regions of Germany. The landscape is wide and open, with hedgeless fields, no trees, and large compact villages. Wheat and sugar-beet are the chief crops. Hanover, Brunswick, Magdeburg, and Leipzig are old trading towns, as well as great agricultural and manufacturing centres.

3. CENTRAL AND WEST GERMANY is a region of great complexity. Its high plateaux, forested hills, and small lowlands form a barrier between north and south Germany. The principal rivers, flowing from south to north, have formed historic routeways piercing the highlands, and give some unity. Three main divisions can be traced: (1) the Rhineland, (2) the upper Weser and Hesse hill country, (3) the middle Elbe and Thuringia.

The Rhine plateau is a broad highland block of hard old rocks, mainly slates and sandstones, with a general height of 1,500–2,000 feet and a remarkably level sky-line. The Rhine flows across it from south-east to north-west, and from Mainz to Bonn has cut a deep, steep-sided gorge, below which the river enters the north German lowland. The Moselle is the chief tributary of the Rhine and, like most of its tributaries, winds in the bottom of a deep valley below steep, often

GERMANY

forested, slopes. The rivers have divided the plateau into separate blocks. West of the Rhine are the highest parts of the plateau, including the Hünsruck and the Eifel hills, which are forested and sparsely peopled. The surface of the Eifel is broken by old volcanic stumps and crater lakes. East of the Rhine the upper levels of the plateaux are undulating or gently hilly. The heights are covered by thick pine, spruce, beech, and oak forests, and the lower slopes are a mixture of coppice, pasture, and a few arable fields. The region is thinly peopled. Most villages and towns are concentrated in the deep narrow valleys, particularly in the south, where the well-drained, sunny slopes have been cleared of forest for the cultivation of the vine. The Moselle valley and the southern slopes of the Taunus are famous for their wines.

Along the northern edge of this region lies the Ruhr–Westphalian coal-field, before 1939 the greatest coal-producing area in Europe. It was the basis for a huge concentration of heavy iron and steel industries, with houses and factories stretching almost continuously for many miles. With the Rhine to provide cheap and easy transport for its industries, the Ruhr had a huge world trade on which Germany's prosperity largely depended. To the south of the Rhine plateau lies another but smaller coal-field, just east of the Saar River, a tributary of the Moselle. This is the basis of the small Saar industrial area. Cologne is the most important city of the Rhineland.

East of the Rhine plateau is the River Weser and the Hesse hill country. Here a complicated series of low hills and plateaux of sandstone and limestone alternate with small, hill-encircled lowlands and broad valleys. The whole country-side is most prosperous-looking. Large villages lie amongst well-tilled and hedgeless fields. The lowland soils are fertile, and there are orchards in sheltered parts. Above the fields, hills and plateaux rise gently in slopes broken here and there by steep limestone cliffs. The heights are all crowned by woods, especially the pine and spruce forests, so characteristic of central and south Germany. This type of country stretches southwards to the volcanic Vogelsgebirge. These are high and covered by forests and rough mountain pastures, their flanks scored by deep valleys. Through this region run important routeways between south and north Germany.

East of the Hesse hills lie Thuringia and Saxony. The rivers all flow to the Elbe, the main north–south routeway. The Harz mountains in the north, and the Thüringer Wald and the Erz Gebirge in the south, are high rounded plateaux, cut by deep valleys and covered with dense pine forests, except the highest points, which are moorlands. The soil is poor, the winters long and severe, and the mountains would be very thinly peopled were it not for the many rich mineral deposits which have been mined for centuries. Although these minerals have now lost their importance, the people remain in the valleys, employed in such industries as wood, glass, pottery, leather, and textiles. DRESDEN (q.v.) is the chief town. In all these mountains there are many spas and health resorts.

East and north of the highlands, the Thuringian and Saxony lowlands slope gently eastwards. Wooded limestone and sandstone hills

ri· above areas of well-drained fertile soil, which h· been settled since prehistoric times. The l· scape is rich and open, growing wheat, s· -beet, and fruit, with cattle pastures on the · r clay soils. This important agricultural · helps to feed the industrial areas of the · and Silesian coal-fields (now in Poland). buildings are built of wood and plaster, ual materials throughout central and south ny.

South Germany lies south of the Rhine u and the Thüringer Wald. In the west e upper Rhine and lower Main plains en Basle and Mainz, often called 'the gar- f Germany'. The deep rift-valley is well red, and the climate is hot, dry, and sunny. traightened course of the Rhine, an im- nt waterway, flows between coppice and -meadow below the Rhine terraces. The of cereals, fruit, and hops are the highest rmany. On the deep soils of the bordering les are continuous vineyards, with deep cellarage for the wine. To the east, the is bordered by the Black Forest and the wald, both high, thinly peopled plateaux red by dense fir and spruce forests.

e rest of south Germany falls into four main s—the Main and Neckar scarplands, the Mountains, the Danube valley and arian foreland, and the mountain borders.

e Main and Neckar rivers rise in the Jura the source of the Danube, and flow north west to the Rhine. In their lower courses cut through the sandstone in a series of tacular gorges, below steep, red cliffs, wned with fir forests. The whole of the iddle and upper courses of these rivers and their tributaries lies in an extensive hill and vale country. The low hills are mostly covered by dense forests of pine and beech, but below them stretch open arable fields and pasture land. Cultivation is particularly intense along the Main and Neckar valleys, where vineyards and hop-gardens are found on all the dry, sunny slopes. The many towns are all regional capitals of historic and cultural importance, and centres of communication, Stuttgart, Würzburg, Schweinfurt, and Nuremberg being the most important.

The Jura Mountains, in Swabia and Franconia, sweep in a broad crescent from south-west to north-east. The country is bleak, with little surface water, thin soils, and a covering of rough

ROTHENBURG: A TOWN IN SOUTHERN GERMANY

mountain pasture and forests. The northern steep hill-side is cut by gorges into high cliffs, many crowned by historic castles.

At the foot of the southern slopes of the Jura, the broad river Danube flows eastwards, sometimes through deep gorges, sometimes across swampy lowlands bordered by cultivated terraces. It has never been a very important German waterway, but its valley has always been a strategic routeway into Europe from the east.

South of the Danube the Bavarian foreland rises gradually to the Bavarian Alps. The high foreland has an undulating surface, cut by many right-bank tributaries of the Danube. Each river flows through meadow and wet woodland in a marshy valley, cut into the great mass of sands, gravels, and glacial drift brought down by former glaciers from the Alps. The higher better-drained strips between the rivers are a mosaic of pine forests, open cultivated terraces, patches of heathland, moors, and peat-bogs. Because of the height and northward slope of the land, the winters are cold and wet, and agriculture is restricted to hardy crops. The population is mainly rural, apart from two large towns, Munich (q.v.), the great industrial centre of the south, and Augsburg.

The Bavarian Alps, the Bavarian Forest, and the Bohemian Forest (or Böhmer Wald) are the

frontiers of Germany in the south and south-east. They are high, rugged mountain ranges, cut by deep gorges and, except for the highest summits, covered by dense coniferous forests. The Alpine peaks rise above the permanent snow-line.

See also ALPS; DANUBE; RHINE; BERLIN; DRESDEN; FRANKFURT; HAMBURG; MUNICH.
See also Vol. I: GERMANS.

GEYSER. This word comes from the Icelandic *geysir*, meaning a gusher or rager. Geysers are natural springs or fountains which at more or less regular intervals hurl masses of hot water and steam up into the air. They are found only in districts where volcanic activity, though dormant, has not yet quite ceased, the most famous being those in Iceland, New Zealand, and Yellowstone Park, U.S.A. The cause of the intermittent spouting of geysers lies in the fact that the boiling-point of water or any liquid depends on its PRESSURE (q.v.). (A familiar example of this is the impossibility of boiling an egg on a very high mountain, since at that altitude the pressure is so reduced that the boiling-point of water is too low to set the egg.) Every

THE GREAT GEYSER, ICELAND
Royal Geographical Society

STEAM RISING FROM THE HOT SPRINGS OF ROTORUA, NORTH ISLAND, NEW ZEALAND

geyser consists of a long tube down through the earth, probably following some crack caused by volcanic energy. The temperature of the earth in the lower parts of the tube is well above normal boiling-point, being highest where the depth is greatest. As soon as the water at or near the bottom reaches a temperature at which it must boil, the whole column is raised upwards by the pressure of steam. By this means much of the water above, already heated above normal boiling-point, is carried upwards and the pressure on it reduced so much that it, too, boils instantly. The whole tube then squirts its contents violently up in the air to a great height.

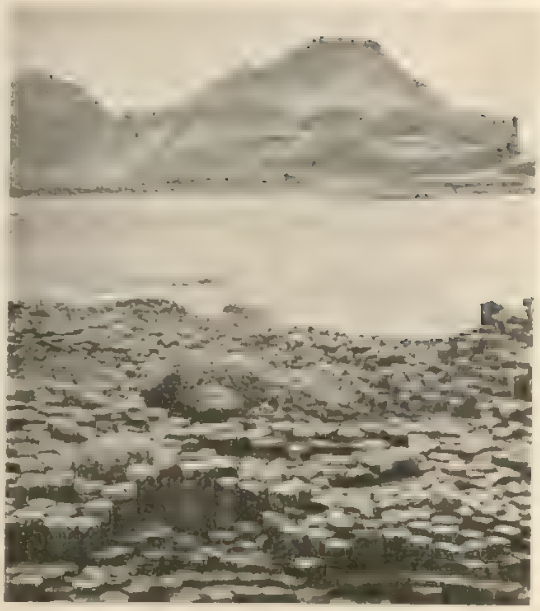
Hot water is able to dissolve far more mineral salts from the earth than cold, and these must be deposited when the water cools or evaporates. Consequently, most geysers and hot springs build around themselves fantastic ornamentations of lime and silica. They are further helped in this by the action of certain minute organisms called 'algae' which flourish in the warm water and secrete these minerals in their skeletons. As a result of these processes (which may be compared to the formation of stalactites and stalagmites in CAVES and to the building of CORAL ISLANDS, qq.v.) the basin of a geyser slowly builds itself up higher and higher, like the crater of a volcano. The 'Great Geyser', in Iceland,

...mple, has a basin of white silica, about 60 ... ross and 4 feet deep, on top of a 40-foot ...d of the same material. The tube down the ...e is over 70 feet deep. The intervals be- ...eruptions vary from 6 to 30 hours, and the ... to which water is thrown, from 80 to ...et. But the most spectacular geysers are ...ly those in the Yellowstone region of ...rica. The best known of these, 'Old Faith- ...vas so called from the regularity with ...it hurled up water and steam for 5 minutes ...tervals of about an hour. Jets from the ...ve' exceed a height of 200 feet and drift ...s spray and steam, none falling back into th... asin. In this district, too, is the beautiful ...te Mountain', a lofty mass of white lime de...sits with a basin at the top about 150 yards in ...ameter. From this the pale green water tri...les down over a series of terraces into va...ous pools, growing cooler as it descends—so th... bathers are able to choose water of any te...erature they please.

... geysers of the Rotorua district of Auck- la... in New Zealand were started off again by a ...strous eruption in 1886. As well as causing m... loss of life and damage to property, this ...oved the famous and beautiful system of te...ces. At the time of the eruption, mud, ... stones, and steam were hurled nearly ... feet into the air. To-day, in addition to g...ers, there are remarkable pools of boiling m... or water, jets of steam, and fantastic rock fo...ations. In some places, both in New Zea- land and in America, it is said that you can hook a trout in a cool stream of water and, without moving your feet, cast it still hooked into a hot stream where it will cook. In fact, the salts in the hot springs are so strong that the trout would not taste very good. Both in New Zealand and in America the pools catching the hot water are much used by bathers and also by invalids who benefit from the minerals dissolved in them.

See also VOLCANOES.

GIANT'S CAUSEWAY. This is one of the natural wonders of the world, and lies on the northern coast of Ireland, near Portrush in the county of Antrim. It consists of thousands of columns of reddish basalt rock, generally six-sided, set closely together in a honeycomb formation. The columns differ in height, and form in the Grand Causeway a sort of giant staircase leading down to the sea. There are picturesque and grotesque formations, such as the Giant's Organ, where the columns rise high into the air, reminding the onlooker of the pipes of a great church organ. The Wishing Chair is built of a single pillar surrounded by higher pillars, giving it the shape of an arm-chair.



THE GIANT'S CAUSEWAY, NORTHERN IRELAND
R. Welch

There are many legends which attempt to explain the origin of the Giant's Causeway, the most popular being that Finn MacCool, a legendary Irish giant, built it in order to cross to the Scottish Coast (*see* GIANTS, Vol. I).

Geologists say that it was caused by the rapid cooling and cracking of a sheet of basalt, which poured over the land from a fissure eruption in the Tertiary Geological Period several million years ago. Most of the basalt columns are six-sided, but there is one—the keystone—with three sides, and a few others with seven, eight, and nine sides.

See also ROCK FORMATION; ROCKS, Section 2 (*a*); VOLCANOES.

GIBRALTAR. The narrow Straits of Gibraltar lie at the western end of the Mediterranean Sea between two massive promontories, 15 miles apart, which were known to the ancients as the Pillars of Hercules. Although the straits look placid, there is a strong eastward current—and sailors used to believe that, but for the giant

THE ROCK OF GIBRALTAR FROM THE SOUTH. *Dorien Leigh*

pillars, there would be a rush of waters from the unknown Western Ocean that would surely overwhelm the shores of the inland sea. In later years, when the Chapel of St. Europa was built on the Spanish side (where modern Gibraltar is to-day), it became a centre for pilgrims, and ships fired a salute as they sailed by.

The Rock of Gibraltar stands on a prong of the northern promontory, 3½ miles long. Its northern end is a low-lying sandy isthmus, half a mile wide, known to the Spanish as the Devil's Gate. Above it the north end of the Rock rises sheer to 1,000 feet and is called *Salto del Lobo*, the wolf's leap. The ridge of the Rock runs due south, reaching two summits, Middle Hill, rising to over 1,400 feet, and O'Hara's Tower, which commands the straits. The southern face of the Rock slopes down to Windmill Hill and the flat plateau known as Europa Flats. The east side is much steeper and more inaccessible than the west, on the slopes of which lies the town of Gibraltar. The promontory forms the east side of the magnificent Bay of Gibraltar. The Spanish port of Algeciras is 5 miles west on its other side.

Although long known and revered, Gibraltar seems to have been uninhabited until the 8th century except for the apes that lived in its caves. In A.D. 710, however, southern Spain was invaded by the Moors, and in the following year Tariq-ibn-Zeid landed with more men and took possession of the Rock, renaming it Jebel-Tariq (mountain of Tariq), corrupted later by the British to Gibraltar.

For 7½ centuries Gibraltar was a Moorish stronghold. The caves and potholes with which the limestone mass is riddled were fortified, and during the struggle between Moslems and Christians the Rock withstood eight sieges. In 1462 it fell to the Christians, but continued to be attacked and besieged during the many civil wars that troubled Spain. In 1704 Sir George Rooke, with Dutch help, captured it and claimed it for Britain.

For a time after 1705, when it was declared a Free Port, Gibraltar lost orderly rule and most of the Spanish population fled. The shrine, the convent, and the many churches were pillaged and turned into store-houses, while the town gained an ill reputation as a haunt of smugglers and criminals. Under the command of General Eliot it withstood the joint Spanish and French siege of 1779, and Nelson found it an important base for his Mediterranean campaign in the Napoleonic Wars.

By the end of the 19th century the value of Gibraltar as a natural and practically impregnable fortress had become apparent. More fortifications were built, the garrison was increased, and the town properly administered. It is a useful fueling station and port of call for ships *en route* for India and is a repairing depot for British warships, the fine harbour making an excellent naval base for the Mediterranean Fleet. Although it gradually lost much of its importance to Malta, and though aircraft and high explosives have made it more vulnerable, nevertheless, during the World War of 1939–45, it was an important base for operations, and the caves made natural, deep air-raid shelters. In 1943 a new subterranean cavern of great beauty, with stalactites and stalagmites, was re-discovered.

All food has to be imported to Gibraltar; but water is obtained by covering large sections of the rock with concrete, off which rain-water drains into storage tanks. A large proportion of the workers in the docks and harbour are Spanish and come from the neighbouring vil-

lages of La Linea and San Roque. The civilian population of the town numbers about 20,000 and is very cosmopolitan, thereby reflecting the colourful history of the fortress and its position at one of the great cross-roads of the world.

GILBERT ISLANDS, *see* PACIFIC ISLANDS.

GLACIATION. This is the work done by large volumes of ice—either as ice-sheets or as glaciers—in shaping the form of the land. Wherever there have been ice-sheets or glaciers the ground bears evidences of them. In some areas, the ice has worn away and carried off large quantities of rock and earth, while in other areas, material has either been left by the ice as it melted, or has been washed away and deposited by rivers beyond the edges of the ice-sheet.

Mountain areas in glaciated country are distinctive in form. They are bare and rocky, and their peaks are steep and pyramidal, while ridges are narrow and pointed. Deep cliff-sided semicircular amphitheatres, often holding a lake, hollow their sides. These are known in Scotland as *corries*, in Wales as *cwms*, and in France as *cirques*. There is a theory that the narrow ridges and peaks were formed by the corries having been cut back farther and farther by the ice. All the high mountain ranges of the world have fine examples of glaciated summits and ridges, the most spectacular in Europe being in the Swiss Alps. The valleys show the effects of glaciation, too, for the ice packed itself into solid masses called GLACIERS (q.v.), which broadened and deepened existing river valleys into deep U-shaped troughs, straightening out curves at the same time—for ice has not the fluidity of water.

The erosive or wearing-away power of glaciers results from the weight of the mass of ice and from the stones and rocks embedded in it. These gouge and scoop away the softer material in the path of the glacier, and score and scratch the harder rock. The sides and floors of glaciated valleys bear ample evidence of this. The scores or scratches are called 'striae'.

CADER IDRIS: A CWM FORMED BY GLACIATION

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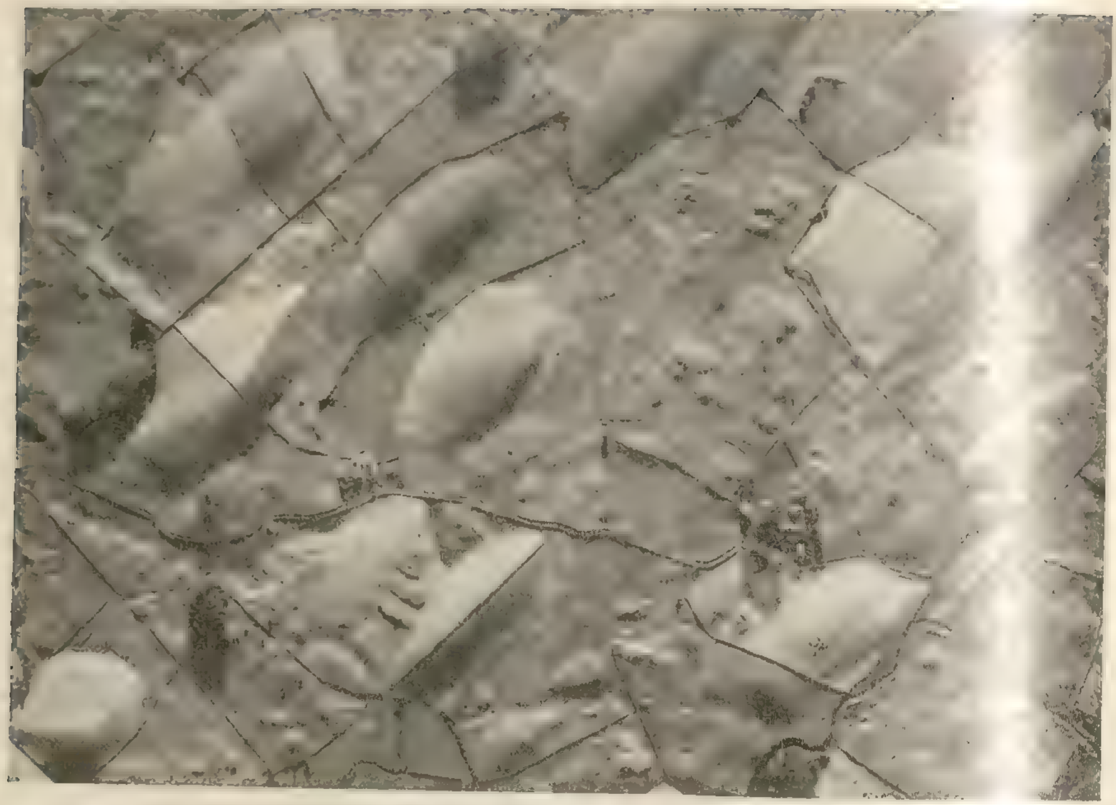
When glaciers filled the valleys, they filled them to the top of the U-shape, and as tributary glaciers entered at the level of the ice surface, their valleys to-day are high above the main valley floor and are called 'hanging valleys'.

The small amount of material deposited by glaciers is found in places where they have left the mountains and spread out over the lowlands. The 'terminal moraine' or heap of debris at the lower end of a glacier marks the division between two kinds of deposit—the material at the bottom of the glacier and the material washed out from it. The bottom of a glacier is made up of rock and mud bound together in ice: when the ice melts, this 'ground moraine' of 'boulder-clay' is left behind as a zone of hilly country. Beyond the terminal moraine, streams of water from the melted glacier carry sands and gravels and deposit them in broad, flat, bedded layers.

The largest glaciated lowlands, however, are the result of ice-sheets. Ice-sheets smoothed out the original relief, sometimes leaving barren plateaux of bare rock with shallow lakes or bogs, but usually covering the land with deposits of boulder-clay, sands, and gravels. Boulder-clay country resulting from ice-sheets varies greatly in form: it may be gently undulating, or it may be plateau-like with small lakes in shallow hollows, as in Finland and north-west Canada, or it may be a series of 'drumlins'. Drumlins are long oval-shaped mounds of boulder-clay, ranged roughly in the direction of the flow of the ice, in



DRUMLINS IN SOUTH-WEST SCOTLAND
The hillocks show up well from the air. *Crown Copyright Reserved*

some places making gently undulating country, in others rising to 200 or 300 feet. Sometimes there are also ridges of sand and gravel, called 'eskers' and 'kames'. These are usually more curved and with much steeper sides.

In glaciated lowlands there are often found isolated hills of very hard rock. Such hills commonly are of the form known as 'crag and tail' and are to be seen, for instance, in Scotland, where the Castle Rock of Edinburgh is a well-known example. A long smooth shape climbs up with the direction of the ice advance, and there is a steep slope on the lee side, often masked to some extent by the deposition of boulder-clay.

Ice-sheets and glaciers, in the very distant past, often carried huge boulders many miles from their place of origin and, when the ice melted, dropped them in very different country-side. These are called 'erratic boulders', because they have wandered from their original area. For example, blocks of Norwegian crystalline rock are to be found in north-east England; and in many parts of the world huge stones are found perched precariously on hill-tops.

The presence of modern glaciers and ice-sheets has been of great help in the study of glaciation; although the glaciers and ice-sheets which shaped many of the present glaciated landscapes were the very much vaster ones of the great Ice Age.

See also ICE AGE; ROCK FORMATION; ROCKS, Section 3(*d*).

GLACIER. This is a river of ice flowing from high up in the mountains down to lower levels. Except that it flows too slowly for any movement to be seen, a glacier behaves very much like an ordinary river. It has a definite channel down which it flows faster or slower according to the steepness; it cuts or wears away rocks, gravel, sand, and earth from its course and carries them along with it: and finally it flows into the sea or a lake, either as water or still as ice.

On all really high mountains there is a line above which there is always snow, because the temperature is always below freezing-point. This line is called the snow-line. Storms are continually increasing the amount of snow on the ground above it, particularly in the valleys,

LOGAN GLACIER, ALASKA

The photograph shows medial moraines formed at the junction of tributary glaciers. *Bradford Washburn*

and as the snow does not melt, nature finds other ways of relieving the increasing pressure.

The weight of the snow and the influence of gravity soon cause the mass to begin to move outwards and downwards from the summit of the snow-field. If the slope is very steep, the mass breaks off as an AVALANCHE (q.v.). If it is less steep, the snow moves slowly down each valley as a glacier. The great weight of the upper layers of snow causes the lower ones to be converted into ice. Thus rivers of solid ice are always moving like great tongues from the regions of perpetual snow, fed by an inexhaustible supply of snow. In the higher parts of the glacial valley especially, the weight of ice is much greater; and the movement of downward flow is more rapid in the centre of the glacier than at the sides. Stakes driven into the ice right across a glacier will move down with it, but after some time the row of stakes becomes curved, because those in the middle have been carried farther than those on the outside. It has been found that the summer movement of some of the big Alpine glaciers is about 20 inches per day in the middle, but only about 13 inches at the sides.

The vast moving mass of ice has enormous power. It fills the mountain valley, and gouges out the sides into the shape of a great U, carrying loose rocks along with it. It possesses enormous 'picking up' power, so that a great deal of earth and other debris is carried down on the underside. This has in time the effect of deepening the valley. A glacier is thus an effective agent of DENUDATION (q.v.).

Tributary glaciers sometimes join the bigger ones on the way down, bringing their own loads with them. All this mass of soil and rock-waste, gravel, sand, and other debris eventually gets deposited somewhere. The glaciers move steadily on, down and down, far below the snow-line, into regions where the temperature is high enough to melt them. When they reach a point where the supply of ice and snow from above is not as great as the thawing rate, they come to an end, as glaciers, depositing their load of debris in what is called a 'terminal moraine'. The stream of melted ice issuing from the end of a

glacier is sometimes the source of a big river. The River Rhône, for example, rises in a glacier in the Swiss Alps. Such streams are always muddied by the fine debris produced by the friction of the glacier against its bed. Very often this is deposited farther on in beds of sand or gravel. When a geologist comes across such beds, he will have to decide, if other signs are present, whether the country-side has been shaped at some period in the past by GLACIATION (q.v.), the action of ice.

In POLAR REGIONS (q.v.), where islands and mountains are often completely covered by an ice cap, the ice moves gradually towards the sea, and then breaks off, floating away as ICEBERGS (q.v.). The size of the icebergs, of which only one-ninth shows above water, gives some indication of the great depth of the glacier from which they have come: some, indeed, are known to have a total depth of 1,000 feet.

In addition to its terminal moraine, a glacier also deposits much rock-waste along its actual course. This is composed of material which is scraped off the sides of the valley or falls on the surface of the ice from above. It is left in a line along each side of the glacier. Such deposits are called 'lateral moraines'. When a tributary glacier flows in, the two lateral moraines inside the junction unite and form what is called a 'medial moraine' down the centre of the main valley. All these features can be recognized to-day in mountain valleys which have once been partly filled by ice—it may be hundreds of thousands of years ago.

All our mountains in the British Isles are now below the snow-line, but during the ICE AGE (q.v.) they were all well above, and the ice-sheet extended as far south as Oxford. The loads of clay and rock material carried by glaciers now cover the lowlands and plains with what is known as 'boulder-clay'. In places where this is not too stony, it forms good soil, containing, as it does, the ground-down mixture of all the different rocks which it has passed over.

According to the slope and unevenness of the ground beneath it, the surface of a glacier may either be broken up into the wildest confusion of pinnacles, blocks, and towers of ice, or split and cracked into fissures perhaps hundreds of feet deep. These 'crevasses' can be a source of great danger to mountaineers, especially when they are lightly bridged by snow. Many climbers have lost their lives in them. When an accident of this kind occurs in a crevasse from which no rescue can be made, the local guides can predict fairly accurately how long it will be before the body of the victim reaches the end of the glacier, where the slow flow of ice will eventually bring it. There have been instances when the survivors of an accident have gone as old men to see the body of their old-time companion removed for burial—and found it, preserved perfectly in the ice through the years, looking as youthful as on the day of the tragedy.

GLASGOW. With a population of nearly 1,100,000, Glasgow was for long the second largest city in the British Isles; but BIRMINGHAM (q.v.) has now surpassed it. It lies in the central lowland of Scotland, on the River Clyde, 22 miles from the sea. Famous as a great port, for its shipbuilding yards, and for its engineering industries, it is the centre of the industrial region which has grown up on the coal-fields of Lanarkshire and Ayrshire. Surrounding the city are many smaller industrial towns, each of which specializes in some industry, such as cotton manufacture, chemicals, metal goods, machinery, or shipbuilding. The greater part of Scotland's industrial capacity and of her population is concentrated in and around Glasgow.

The rise of the city dates from the early 18th century, when, after the Treaty of Union with England in 1707, Scotland was free to share in foreign trade, particularly with the American Colonies. Till then, Glasgow had been no more than a small cathedral and market town; but now Glasgow ships traded with Ireland, Europe, America, and the West Indies, bringing back tobacco, sugar, rum, and cotton. Glasgow became a great commercial centre. The tobacco trade produced the most important financiers—and these 'Tobacco Lords', richly dressed and with retinues of servants, could be seen on their way to their offices or the Exchange. Streets of solid grey stone buildings, with exciting names like Jamaica Street, India Street, and Havana Street, grew up near the docks. These streets are still there, but they are now shabby and disreputable. New docks were built, and a deep channel dredged in the river: to-day all but the largest ships can pass upstream to dock in the heart of the city.

Towards the end of the 18th century, cotton began to take the place of tobacco as the main industry of Glasgow. The city was in a favour-

able position to import raw cotton from America, and there was plenty of water available to work the spinning and weaving mills. In the 19th century, the coal-fields of Lanarkshire and Ayrshire were exploited, and heavy industries such as shipbuilding, engineering, and the manufacture of machinery of all kinds became established.

In appearance, Glasgow is grey and drab, its population crowded into vast stone tenements or flats. The shopping and business centre is laid out in even, rectangular blocks of solid stone buildings, intersected by straight streets crossing at right-angles. Kelvingrove Park, which contains the fine buildings of the University, is surrounded by the solidly built villas of the richer people.

Despite the grimness of their city, the people of Glasgow are famed for their hospitality, especially to strangers. In summer, during the annual holiday, many thousands of holiday-makers leave the grey city, and sail on pleasure steamers to the seaside resorts on the Clyde estuary.

See also Scotland.
See also Vol. I: Scots.

GOBI DESERT, *see* Deserts; Mongolia.

GOLD, *see* Metal Ores. *See also* Vol. VII: Gold Mining.

GOLD COAST, *see* Guinea Lands.

GRANADA. Of all the colourful cities of Spain, Granada, perhaps, captures the imagination most. It is magnificently sited on and between two hills where the Rivers Genil and Darro meet, at the foot of the Sierra Nevada (*see* Map, p. 160). Granada may be a form of the Spanish word for 'pomegranate', a locally grown fruit, but more likely it has an Arabic derivation and means 'the hill of strangers', for Granada was the last stronghold of the Moors (q.v. Vol. I) in Spain.

There had been a settlement on the site since earliest times. The Romans made it a centre, for it controlled two passes over the Sierra Nevada, one of which to-day carries a road to Motril and the other a railway to Almeria. It was the capital of the Moorish kings from 1248 to 1491, and they built two fortresses above the town, the Alhambra and the Generalife. The town itself grew and prospered amidst the irrigated gardens, fields, and orchards laid out by the Moors. It became the centre of the silk, flax, and metal industries, and a seat of Arabic learning and art.

The famous Alhambra was built in the 14th century, and although it has been defaced and damaged, it is still one of the world's finest pieces of architecture and the most perfect example of Moorish art. Outside, it appears austere and forbidding; but this merely heightens the effect

THE ALHAMBRA, GRANADA
P. Hart

of splendour within. The Palace is unsurpassed in the exquisite detail of its marble pillars and arches, its fretted ceilings, and the veil-like transparency of its filigree work in stucco.

With the expulsion of the Moors from Spain, Granada lost its importance. It is to-day a provincial centre with a population of about 153,000. It has always attracted the poet and the artist because of the beauty of its setting, and in the years before the Spanish Civil War it was the home in Spain of new music and poetry.

GRAND CANYON OF COLORADO, *see* Colorado Canyon.

GRANITE, *see* Rocks, Section 2 (*b*).

GRASSLANDS. 1. Great areas of lowland clothed with rough grass cover large parts of the earth's surface. These are for the most part huge plains, stretching to the horizon with few or no trees to break the monotony. In winter, strong biting winds with nothing to break their force make the climate very cold; in summer, there is no protection from the glaring sun. These great grasslands occur mainly in the interiors of the continents, for it is here that the conditions of rainfall and temperature are right for them. Only about 15 inches of rain a year is needed to support grass, provided that the rain comes in the growing season in early summer. The belts of grassland lie between the Forest regions (q.v.), where rainfall is greater, and the Deserts (q.v.), where nothing will grow because the rainfall is less than 10 inches a year. The types of grass found in the different areas depend on the temperature and also on the kind of soil. Tropical grasslands, for instance, grow a much coarser and higher grass than those in the temperate zones. Grasslands are given different names according to the continent in which they are found: in Asia they are 'steppes'; in Africa, 'savannahs' (where they are tropical) and 'veld' (where they are temperate); in North America they are 'prairies'; in tropical South America they are 'campos' or 'llanos'; and in Argentina and Uruguay they are 'pampas'.

There are certain areas where the temperature and rainfall are quite suitable for natural forest, but where there is not enough depth of soil for trees. For instance, on the Downs and on Salisbury Plain in England (q.v.) the soil is thin and chalky, but the adequate rainfall makes the grass, though only a few inches high, green and succulent and excellent for sheep pasturage. Such grasslands are small in area compared with the great tracts in the continental interiors.

2. Tropical Grasslands. In central Africa, the savannahs are great areas of rolling plains lying to the north and south of the equatorial forests. The grass is coarse, and grows high enough to hide a man standing upright. This grass has been appropriately called elephant grass. It grows quickly during the rainy season in early summer; but as the drought and heat increase, it becomes parched and dies down. Grass fires sometimes sweep over the savannahs with appalling speed, leaving huge areas charred and desolate. There are no trees, except a few types able to retain moisture in their thick shiny leaves and thick bark. To the north and south of the savannahs, as the rainfall grows less, the grass becomes poorer, and finally deteriorates into scrub and desert—the Sahara (q.v.) in the north, and the Kalahari in the south. Mountain grasslands in Kenya and Uganda (*see* East Africa) form a corridor of grassland linking the savannahs north and south of the Equator. The nomadic tribes of central Africa move freely over this grassland with their cattle, often driven by drought or by savannah fires to seek fresh pastures. The herdsmen have to protect themselves and their cattle not only from the Tsetse Fly (q.v. Vol. II), which brings sleeping sickness, but also from the attacks of the great beasts of prey—lions and leopards. These also cause havoc among the herds of antelope, zebra, and deer which roam over the savannahs.

In South America, there are two separate areas of tropical grassland: the llanos, north of the equatorial forest in Venezuela, and the campos, in Brazil and Paraguay (qq.v). The llanos are huge, almost flat plains, about 400 feet above sea-level, covered with tall rank grass. Through them wind the River Orinoco and its many tributaries, spilling out in flood over huge areas during the rainy season. As the waters retreat, the grass springs up rapidly, but is soon parched by the intense heat of summer. There are few trees except those which grow in belts along the rivers. There used to be vast herds of half-wild cattle on the llanos, herded by a hardy race of herdsmen called 'llaneros'; but now there is little animal life. The campos are much higher, lying about 2,000 feet above sea-level. They are divided into separate upland areas by

AFRICAN SAVANNAH. *Crown Copyright Reserved*

SOUTH AMERICAN PAMPAS. *Ewing Galloway, N.Y.*

RUSSIAN STEPPE. *S.C.R.*

deep river valleys. The variety of local climate gives equal variety of grasslands—in some places rich pasture, in others poor and dry. At intervals, droughts occur, bringing famine and death to all living things.

3. Temperate Grasslands. In the south of South America are the pampas, the temperate grasslands of Argentina and Uruguay (qq.v.). The soil of these rolling plains is fertile, and the natural grasses have in many places been replaced by more nourishing varieties, such as alfalfa. Huge herds of cattle and sheep live on the pampas, and on these depend the great meat-exporting industries of South America. Many thousands of acres have been ploughed up and are now the enormous wheat lands of Argentine, one of the great wheat-producing countries of the world. In those areas where the pampas is in its original state, game animals such as deer, foxes, and opossum are found, and occasionally a jaguar in search of prey. There are very many birds, ranging from the rhea, an ostrich-like bird, to tiny humming birds.

In South Africa (q.v.) is the veld (which means field), where, especially in the Transvaal, cattle and sheep-rearing is carried on by the descendants of the early Dutch settlers. There used to be a great many game animals on the veld; but now, except for those preserved in game reserves, they have almost died out. In Australia (q.v.) sheep-farming on a large scale is practised on the natural grasslands of Queensland and New South Wales.

In North America, the prairies are the natural grasslands. They stretch from the foothills of the Rocky Mountains to the Great Lakes and to the States of Michigan and Ohio, covering mile after mile of rolling plain. With the advent of modern large-scale farming methods, wheat is grown over large areas where, previously, herds of wild cattle and wandering tribes of Indian horsemen had their homes. Cattle are bred in great herds in the ranges of the Rockies' foothills—for example, in the States of Montana and Wyoming. These herds are controlled by cowboys on their hardy ponies, picturesque figures with lassoes and wide-brimmed hats. As the heat of summer parches the grass, the cattle have sometimes to be driven into the hills in search of new pasture. The movements of these vast herds are accompanied by great clouds of dust.

The steppes of the U.S.S.R. are one of the most extensive grasslands of the world, stretching from European Russia into Asia, east and north of the Caspian Sea. Wherever the soil is rich enough, and there is adequate rain, the grassland has been replaced by wheat, which is grown on large collective farms. Elsewhere the steppes are peopled by wandering herdsmen with their cattle and sheep. The chief characteristic of the steppes is their monotony. In all directions stretch rolling seas of wheat or tall brown grass, without any fences or trees to give variety. In spring, bright flowers come up among the grasses, but soon wither away under the heat of the summer sun.

These grasslands of western Asia played an important part in the early history of Europe. They provided wide highways where men and animals could move freely without the hindrance of mountains, rivers, or dense forests. Waves of invaders passed from the East across the steppes in search of new lands. Tartars and Slavs, (qq.v. Vol. I), Magyars and Bulgars, among others, settled in eastern Europe, where their descendants remain to this day.

4. Mountain Grasslands. In addition to the great stretches of lowland grassland, there are small but valuable areas of grassland high up the slopes of mountains above the forest zone, and on high plateaux, as in the Guianas (q.v.). As these reach higher, the temperature and rainfall decrease, and the grass gives way to rock plants and lichens, until the snow-line is reached where nothing will grow. Even on mountains near the Equator, a grassland zone is found, though this is much higher than on mountains in temperate lands. In the Andes in South America, the grasslands lie between 6,000 and 10,000 feet in an area called the *Terra Fria*, the 'cold land'. Very valuable mountain grasslands are found in the mountains of Europe, especially the Alps and the Carpathians (qq.v.). The grass is rich because there is plenty of moisture, and because it grows on good soil deposited on the mountain sides by the glaciers of the Ice Age. In summer the mountain folk drive their cattle and sheep up to the fresh grass above the forests, and when winter comes, the animals are brought down again to the lowland pastures which surround the villages in the valleys. This seasonal migration is carried out in all countries where mountain and plain are adjacent, so that when the lowland pastures are parched by the summer heat, the animals can feed on the mountain grass.

The great grassland tracts of the world are as a rule very sparsely populated; but from them, especially from those of the temperate zones, come the great quantities of wheat and meat, hides and wool, which feed and clothe the densely populated industrial areas of the world.

See also Vol. II: Grasses.
See also Vol. VI: Grasslands.

GRAVEL. This is rock deposit consisting mainly of pebbles less than 4 inches in diameter—stones over 4 inches in diameter are usually regarded as boulders. Gravels may be laid down by melting ice, by rivers, or by the sea (as in the shingle beds of Dungeness and Chesil Beach). Gravels formed by ice usually have angular pebbles, while those formed by wave action have rounded pebbles. River-formed gravels have pebbles which are smooth but less rounded than wave-formed ones, and those formed by slow-moving rivers may consist of stones flattened like biscuits.

Some gravels are important because they contain gem stones or metals such as gold or tin, washed from neighbouring regions. Other river gravels contain stone implements of early man. In gravels laid down by the Thames during the Ice Age, flint implements have been found, and the teeth of such ancient animals as the mammoth and another form of elephant, without hair, which lived in the region during the warm 'genial periods' of the Ice Age (q.v.).

See also Rocks, Section 3.

GRAVITATION (Gravity). This is well known, thanks to the familiar story of Newton (q.v. Vol. V) and the apple, as the force which attracts falling bodies towards the earth. It is not so widely recognized as the force which also attracts the earth towards falling bodies—and, still less, as a universal force tending to draw all bodies towards each other, however little their weight or immense the distance between them. Yet it is possible to calculate with fair accuracy the gravitational pull exerted by this volume on the sun itself.

Aristotle (q.v. Vol. V) believed that there were two opposing properties of matter—weight and lightness—those bodies possessing the former tending to fall, and those with the latter, to rise. He taught, further, that bodies fall at speeds proportional to their weights, the heaviest body reaching the ground first. For 1,900 years no one thought of questioning this view, most of Aristotle's teaching having been accepted as true without proof. In the late 16th century, Galileo (q.v. Vol. V) had his attention drawn to the question by noticing that the swinging of a large bronze lamp in the cathedral at Pisa was always regular in time, however irregular in distance covered—an observation which led him to suggest the pendulum. He came to the conclusion that all bodies must fall with the same acceleration, except as retarded by wind-resistance, and he demonstrated the truth of this to his colleagues on the staff of the University of Pisa by dropping two shots of 10 lb. and 1 lb. simultaneously from the famous leaning tower, and showing that they struck the ground together. How unready the world was at that time to adopt what we now call the 'scientific method' is shown by the fact that the success of Galileo led only to jealousies, and, eventually, to his flight from the city.

It remained for Sir Isaac Newton, born in 1642, the year Galileo died as an old man of 78, to define the Law of Gravitation as follows: 'Every particle of matter in the universe attracts every other particle with a force whose direction is that of the straight line joining them, and whose magnitude is proportional directly as the product of their masses, and inversely as the square of the distance between them'—that is to say, if you double the Mass (q.v.) (or roughly the weight), the attraction is doubled; but if you halve the distance, the attraction is not doubled but multiplied by *twice* two (2 squared) or four, and so on. This law he worked out from a study of the laws which Kepler had found to account for the paths followed by the planets round the sun (*see* Planets). To check it further, Newton studied the moon's orbit and found that the attraction between the earth and its satellite is exactly the same as that which governs the acceleration of a falling body. At the earth's surface this acceleration is approximately 32·2 feet per second per second—i.e. at the end of every second of fall, the speed is 32 feet per second faster than it was a second before.

Since gravitation is a force varying only in proportion to mass and distance, it must be possible to express it as a 'mathematical constant' (or figure which does not vary); and many experiments have been made to find out exactly the value of G, the universal constant of gravitation. In probably the most accurate of these

experiments, two small gold balls were hung at different heights from either end of a short beam made of mirror, itself hung on a much longer thread. The threads were of quartz fibre. Two heavy balls of lead were then placed close to the gold balls in such positions that their attraction would tend to rotate the beam very slightly. The angle through which the beam was turned was watched through a telescope 7 metres (i.e. nearly 23 ft.) away. By this means a movement of less than one second (1/3600 of a degree) could be read. In this way the amount of gravitational force between the balls was measured extremely accurately, no result differing from any other by more than one part in a thousand.

You may wonder why, if the strength of gravitation is 'proportional directly as the product of the masses concerned', Galileo's heavy shot reached the ground no sooner than the light one—since the force exerted on it must have been ten times as great. The explanation is that because the ball was ten times heavier, its 'inertia' was also ten times as great, so that ten times as much force was needed to make it move with the same acceleration as the light ball. It is not the light weight of a feather which makes it float so slowly to the ground: it is the wind-resistance offered by its large area (just as the large area of a parachute enables a man to descend slowly). If a feather and a ton weight were dropped from the same height in a vacuum, they would reach the ground simultaneously.

The gravitational pull of the earth is really in the direction of its centre, and only incidentally towards its surface. As the globe is slightly flattened at the poles, a body at the North or South Pole is nearer the centre of the earth than a body at the Equator, and so it is attracted by a force 1/590 greater and weighs that amount more. Moreover, at the Equator the rotation of the earth causes the weight of all bodies to be reduced by 1/289 owing to the action of what is sometimes, inaccurately, called 'centrifugal force' (*see* MOTION). (In fact, if the earth were to revolve at 17 times its present speed, the force of gravitation would be exactly balanced at the Equator; so that a cricket ball thrown up would continue rising until stopped by wind-resistance.) These two fractions between them account for the difference of 1/194 between polar and equatorial gravity—a difference that could be checked by timing the swings of identical pendulums in each region.

From time to time many theories accounting for the force of gravity have been put forward, and of these many could be neither proved nor disproved. It has been suggested that if there are curves in SPACE (q.v.), as stated in the theory of relativity, these would result in the existence of a force acting in the same way as gravitation. But hitherto it has not been found possible to link up gravitation in any way with electricity, magnetism, light, and other forms of radiation, which are all more or less connected: it has remained obstinately alone and unexplained. Very recently, however, a connexion has been discovered between MAGNETISM (q.v.) and the rotation of large bodies such as the earth, sun, and stars—and in the mathematical formula which states the relation, there appears G, the universal constant of gravitation. So it may not be long now before more is known about the nature of this mysterious force.

GRAVITY, *see* GRAVITATION.

GREAT BARRIER REEF. As ships approach Cairns, a port on the east coast of Australia, they see ahead of them a line of dazzling white stretching across the sea at right angles to their course. It is cut by a blue break. The line is the Pacific rollers breaking on the steep outer edge of the Great Barrier Reef, and the blue break is Trinity Pass, the channel through the reef followed by ships going to Cairns (*see* Map, p. 41).

The Great Barrier Reef, with its length of 1,200 miles—more than twice the distance from London to John o' Groats—is the largest single system of coral reefs in the world. It stretches southward from Torres Straits to Swain Reefs, its distance off the Australian coast varying from 5 miles in the north to 150 in the south. Trinity Pass is only one of several deep passages through the Reef. These are usually situated off the mouths of rivers, since the reef-building coral animals cannot live in fresh water (*see* CORAL ISLANDS).

The Reef, particularly in the south, is a series of reefs rather than one great wall. The outer, or ocean edge, does, however, rise like a wall from considerable depths. Between the Reef and the land is a sheltered channel, strewn with reefs and low coral islands. Vessels bound from Brisbane to north Queensland ports or to the Torres Straits follow this channel, many of them

with special pilots, because navigation in the northern reaches is intricate and difficult.

Black coral from the Barrier Reef used to be exported to India for use as charms and ornaments. Pearl-shell oysters, trochus shell, and the sea-slug or trepang, beloved of Chinese epicures, are found in the shallow waters inside the Reef.

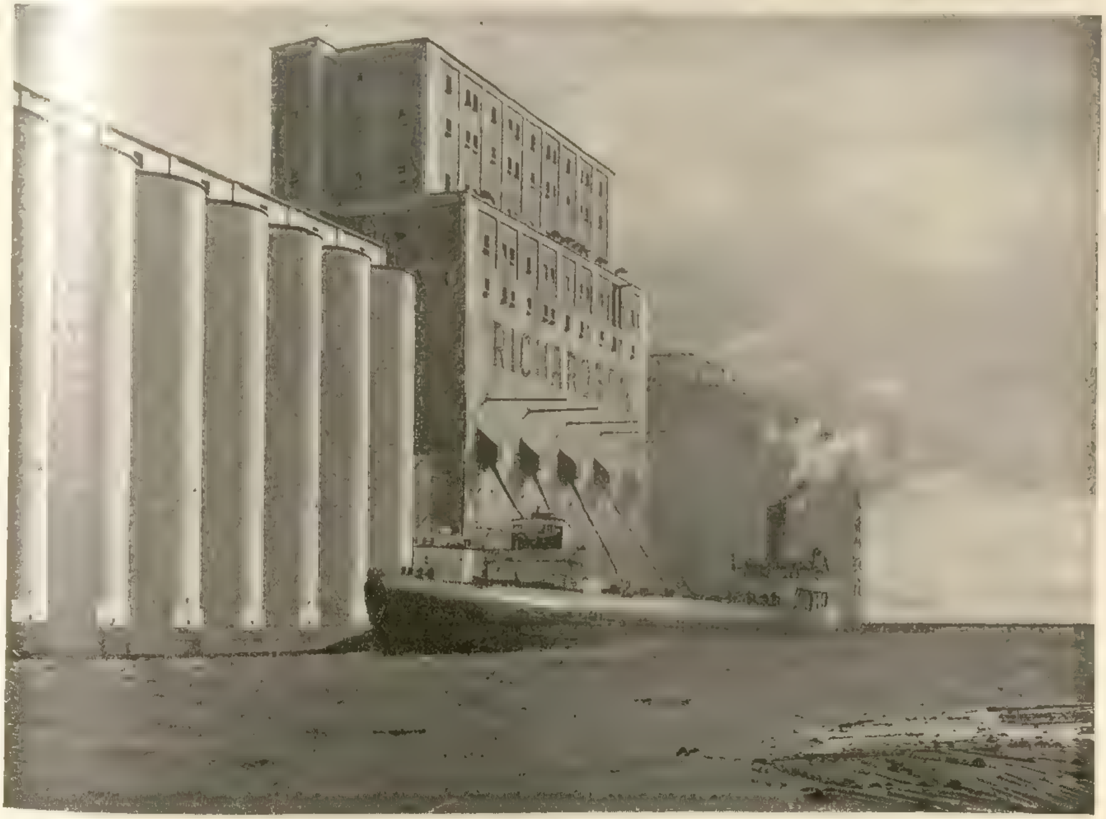
In [illegible] the Reef played an important part in the history of Australia. In that year Louis de Bougainville, the first French circumnavigator of the world, was sailing on a course that would have brought him to the east Australian coast two years before Captain James Cook (q.v. Vol. [illegible]), but when he came amongst the outlying reefs and heard the thunder of the surf, he said it was 'the voice of God'—and he turned back, going round the east end of New Guinea.

In May 1942 the defeat of a Japanese fleet in the Coral Sea, north-east of the Barrier Reef, removed the danger of an invasion of eastern Australia.

See also Australia.

GREAT LAKES. Part of the boundary between the United States of America and Canada is formed by four of the five Great Lakes (*see* Map, p. 318). The largest of these is Lake Superior, which, as its name implies, is the highest above the sea. South of it is Lake Michigan, entirely in United States territory; to the east is Lake Huron, from the southern end of which the St. Clair River leads into Lake Erie. From Lake Erie the Niagara River rushes over the famous Niagara Falls into Lake Ontario, out of which flows the River St. Lawrence (q.v.). An island divides the Niagara Falls (q.v.) into two principal parts, the Canadian Horseshoe Fall and the American Fall, and the neighbourhood has been converted by the Province of Ontario and the State of New York into National Parks maintained for the pleasure of visitors.

All the Lakes are connected by canals or navigable channels, to form not only the largest body of fresh water in the world, but also the most important unit of inland waterway (*see*



LOADING GRAIN AT PORT ARTHUR, LAKE SUPERIOR

Canadian National Film Board

Welland Canal, Vol. IV). The Lakes have a very important place in the economic life of both the United States of America and of Canada. From Chicago at the south-west end of Lake Michigan, railway lines radiate in all directions —across the wheat-growing prairies to Canada, across the Rockies to the Pacific Coast, southwards following the line of the Mississippi to New Orleans—and the city's prosperity has been much increased by its position as a lake port. The iron ore and coal, so vital to its industries, can be brought in cheaply by water—iron across Lake Superior and Lake Michigan, and coal from the port of Cleveland on Lake Erie, which is within easy distance of the Pennsylvanian Coal-field. Another flourishing lake port is Buffalo, at the northern end of Lake Erie. It is the fourth largest port in the United States of America, and the seventh of her industrial cities. From Buffalo, grain from the west goes by way of the Erie Canal and the Hudson River to New York.

Iron ore, grain, and coal are the chief cargoes carried on the Lakes; but cement, sand, timber, livestock, rubber, and cotton are also important. The freighters used are specially designed for big cargoes. Some of them are over 600 feet long, and able to carry half a million bushels of wheat or 6,000 tons of coal or iron ore. Passenger vessels also are large and comfortable. The Lakes can be used only between the months of April and December, as they freeze in winter; but in these 8 months a greater volume of cargo is carried than passes through the Panama and Suez Canals combined in a whole year. The Lakes are jointly owned by the United States of America and Canada. Though Canada has more actual shore-line, the United States has twice as many ports.

The importance of the Lakes is not only commercial: along their shores are vast stretches of forest, meadowland, and grassland, as well as towns, camps, and small country towns. And they are popular holiday places with Americans and Canadians.

See also Canada; United States of America.

GREAT SALT LAKE. The Great Salt Lake is in the U.S.A. in the north-west of the Mormon state of Utah, about 11 miles from Salt Lake City, the capital (*see* Map, p. 451). It is from 25 to 30 feet deep, and is so salty that the human body cannot sink in it. Its present area is about 1,500 square miles—much smaller than the ancient Lake Bonneville of which it is a remnant. The decrease in size is due partly to evaporation, partly to the diversion for irrigation of some of the streams which feed it. The saltness of the lake has increased as its area has diminished, and to-day it is about six times as salty as the ocean, though not as salty as the Dead Sea (q.v.) in Palestine. Three large rivers flow into the Great Salt Lake from the mountains to the east and south-east—the Jordan, the river upon which Salt Lake City stands, the Weber, and the Bear. But it has no outlet.

There are many islands. The largest, Antelope Island, is about 16 miles in length and has a large bathing beach on its southern shore. It is crossed by the Southern Pacific Railroad.

The existence of the Great Salt Lake was known to early travellers. In 1689 Baron Lahontan was told by Indians of 'a Salt Lake 300 miles in circumference'; and in 1776, the year of the Declaration of Independence, the Franciscan Father Escalante reached Great Salt Lake Valley while trying to get to California from New Mexico. He heard of the lake from Indians, but never visited it. In 1824, Jim Bridger, later to become a very famous Rocky Mountains fur trapper and scout, discovered it —and for a time thought, because of its saltness, that it must be an arm of the Pacific Ocean.

See also United States of America.

GREAT WALL OF CHINA. About 200 years before the birth of Christ, a Chinese Emperor called Shi Hwang-ti decided to build a strong wall all along the northern frontier of his country to defend it from the attacks of its enemies. The principal enemies of China in those days were the Huns and the Tartars (qq.v. Vol. I), fierce wild warriors from central Asia. Shi Hwang-ti's wall began at the sea, on the Gulf of Liao tung, just where the present-day China joins Manchukuo. It ends in Kansu province, between the frontiers of what are now Mongolia and Tibet (*see* Map, p. 87). Its total length is 1,500 miles, nearly three times as long as Great Britain from John o' Groats to the tip of Beachy Head.

The Great Wall has been added to, mended, and in some places rebuilt, at various times during its long life, especially during the Ming Dynasty in the 14th century. Branch walls have been added at some places; in others the wall has been doubled to make extra protection. The

THE GREAT WALL OF CHINA

first section, where the wall stepped right down to the edge of the sea, has been destroyed. But in the main it is the same Great Wall that the first Universal Emperor planned and had built, and it still marks the northern boundary of China.

The wall's height is between 20 and 30 feet, its width between 15 and 25 feet at the foot, and about 12 feet at the top—wide enough for two sentries to meet and pass each other. At every 200 yards or so there is a strong guard-house or tower, to be manned by defending troops. At much longer intervals there are gates, connecting with the main roads through China and leading to the principal passes and caravan roads over the mountains or across the great Desert of Gobi. The Wall makes no attempt to find an easy way: it goes uphill and downhill—up 4,000 feet into the mountains, down to the depths of the valleys. Seen from a distance, it looks like an endless snake, tirelessly hurrying on and on and on over the brown hills of China.

The original wall may have been built of rough stones and earth. As bits of it needed mending, later builders used hewn stone and brickwork. The gate-houses are like strong fortresses, with huge gates of thick wood studded with great iron nails, and to this day they defend the entrances to China. They are locked each night with heavy iron keys.

Much of the traffic that goes through the gates in the Wall to-day is not very different from the traffic of the days of Shi Hwang-ti, or of the traffic Marco Polo (q.v. Vol. V) described when he travelled from Venice in the 13th century to visit the great Khan of China. There are caravans of camels, laden with bales of wool or cotton, strings of little donkeys, lumbering mule-drawn carts, flocks of sheep, herds of cattle, cheerful, dirty, overburdened men and women, with their dogs and children. During China's long history of constant wars, hosts of armed men must have poured through the gates of the Wall and down to the rich plains beyond. In the 20th century a new sort of traffic has joined the old through the gates of the Wall—huge roaring

motor-lorries, petrol carriers, motor-cycles, rattling cars. The age-long dusty highways have become modern roads, and petrol-filling stations have appeared at the side of the inns.

See also CHINA; MONGOLIA.
See also Vol. I: CHINESE CIVILIZATION.

GREECE. The Greek State, with about the same land area as England, consists of a very jagged peninsula with an extremely long coastline, and a great number of islands (*see* Map, p. 160). The mainland is a country of high mountains—many summits are over 6,000 feet above sea-level—and of gulfs and bays which penetrate so far inland that no part is much more than 50 miles from the sea. The mountain ranges run in a north-west–south-east direction, and jut out in long narrow peninsulas between the bays and gulfs—as in the prongs of Khalkidike in the north and the fingers of Peloponnesus in the south.

The mountain ranges of northern and central Greece are continuations of the mountains of Albania and Yugoslavia. Many of them are limestone, and high cliffs and gorges are common. The few passes across them have been the scenes of bitter battles from the times of the ancient Greeks up to the Second World War. Mount Olympus (9,571 feet above sea-level) is the highest mountain in Greece, and the awesomeness of its great cliffs makes it easy to understand why the ancient Greeks thought of it as the home of the gods. South-east of Olympus is the Vale of Tempe, famous throughout history for its beauty.

NAUPLION, A COAST TOWN IN PELOPONNESUS

There are very few lowlands in northern and central Greece, and as most of them are flood plains or deltas of rivers, such as the plains of the Vardar and the Struma in Macedonia, or the beds of old lakes, they had to be drained before they could be planted with crops.

Peloponnesus is virtually an island because the narrow isthmus which links it to the rest of the mainland is cut by the Corinth Canal. It has often been compared to a hand with the little finger missing. It has high limestone mountains, many of which rise to over 7,000 feet above sea-level. There are plains at the heads of the three great gulfs, and there are several upland basins, most of which used to be lakes. Different levels of the waters of the lake which used to fill the basin of Tripolis can be seen on the hill-sides round it.

The many islands of the Greek State include the Ionian Isles to the west and almost all of the islands in the Aegean Sea, including the DODECANESE (q.v.) which were transferred from Italy to Greece after the Second World War. The largest of the Greek islands is CRETE (q.v.), which is also the most southerly. Most of the islands are hilly or mountainous, and many of them extremely beautiful—the most spectacular, perhaps, being the crescent-shaped Santorin (Thira) in the south Aegean, whose cliffs tower 1,000 feet above the great basin that was once the crater of a volcano. Some of the islands are very fertile; others are rocky and barren. A few are famous for the beautiful marbles quarried from them.

Central and southern Greece, like other Mediterranean countries, has warm wet winters and hot dry summers. In winter, September to February, rain falls on about 12 days each month, almost always in short heavy showers. There are very few days on which there is no breeze, and in winter there are many gales. Northern Greece has very cold winters, and in the mountains there are very heavy falls of snow.

Greece is an agricultural country, and the

THE RUINS OF A CLASSICAL TEMPLE AT NEMEA, NEAR CORINTH
Marburg, Kunsthist. Seminar

crops have changed very little since the days of the ancient Greeks. Cereals are grown, and olives, figs, almonds, walnuts, and pomegranates, as well as vines for grapes and currants (whose name comes from the great vine-growing area round Corinth). But the country is so mountainous that only a small area can be cultivated, even though many hill-sides are terraced. Scrub or forest and scrub cover wide areas, including most of the hill-sides. Pines, evergreen oaks, deciduous oaks, chestnuts, and beeches are all found, while above 2,000 feet, firs become the predominant tree—except on Mount Olympus, where they are replaced by black pines.

Greece is not a country of large towns, and those that exist, such as ATHENS (q.v.), the capital, and Corinth, are visited more for their ancient ruins than for what they are to-day. One of the most flourishing towns of modern Greece is Corfu, the capital of the largest of the Ionian Islands. The Venetians, during the long period of their occupation from the 15th to the 18th century, built two fortresses which still remain. There are also many fine modern buildings and a very good harbour. The beautiful cities of Candia in Crete and Rhodes on the largest of the Dodecanese Islands are described in the articles on those islands.

See also Vol. I: GREEKS.

GREENLAND. The largest island in the world except for Australia, Greenland is nearly 1,650 miles long and, at its widest, 650 miles broad. Its most northern point lies 440 miles from the North Pole, and is the most northerly land in the world (*see* Map, p. 346). Its most southern point has the same latitude as Oslo and Leningrad. In the late winter it is possible to walk across the ice from Ellesmere Island in the extreme north of Canada; and it was from the west that the earliest known inhabitants entered the country several thousand years ago. These nomadic ESKIMOES (q.v. Vol. I), hunters of walrus, seal, musk-ox, and caribou, settled mainly in the west, and spread gradually to all ice-free coasts.

Nothing was known of Greenland until the 10th century, when Erik the Red, the Icelandic Viking, sighted its coasts and eventually landed in the south-west. He called the island Greenland to encourage settlement. The Norsemen found Greenland much as it is to-day: the interior occupied by two great domes of ice

A SETTLEMENT ON THE COAST OF GREENLAND
Royal Danish Ministry for Foreign Affairs

rising in places to over 10,000 feet, and rimmed by an ice-free rugged border, and by long fiords, and many islands. At the head of the fiords and on the islands there are stretches of lowland. About one-tenth of the total area is free from ice. On the lowlands the Norsemen reared their sheep and cattle, and built their farms and churches (for the settlers were converted to Christianity about A.D. 1000). For 400 years the Norse settlers flourished, numbering perhaps some 2,000. They traded with Norway, Iceland, and Denmark, exporting skins, oil, and ivory, and importing cereals, tin ore, and textiles. But the numbers of new settlers declined, contact with Europe grew less, and gradually they either became absorbed into the Eskimo communities or died out for want of adequate food. By the 16th and 17th centuries, when Frobisher, Davis, Hudson, and Baffin made their voyages, the Norse settlements were in ruins

From the 17th century to the present day, many British, Scandinavian, French, German, and American expeditions have explored the coasts of Greenland. Hans Egede was the chief advocate of colonization by Danes in small trading stations. In the 19th century the less-known and less approachable east coast was explored and mapped by Scoresby and others. Nansen made the first crossing of the ice cap in 1888, J. Ross explored the north-west in 1818, and Peary surveyed the north over a long period up to 1909. In the 20th century there have been several expeditions, notably those of G. Watkins and K. Wegener, to determine meteorological conditions in the interior—for Greenland has a strategic position on the arctic air route between North America and Europe.

Both Norway and Denmark claimed possession of Greenland. Denmark's claim to the west coast was not disputed, and in 1933, her claim to the east coast was upheld by the International Court at The Hague. At present, settlements are strung out along most of the western coast-line. The only settlements of any size on the east side are at Angmagsalik, and Scoresby Sound. All settlements are small, and the total population is only 17,500, of whom 500 are Europeans. The two administrative centres are Godhavn in the north, and Godthaab, with a population of 700, in the south. The Government has carefully controlled alien visitors and trade in order to protect the Eskimoes from harmful European influences. An excellent health service has been organized, doctors and nurses visiting their

patients by boat or sledge. Many schools have been built, and every effort is made to foster native art and literature. Most of the Eskimoes, now called Greenlanders, speak Danish, and are europeanized.

Hunting, sealing, and fishing are still the chief occupations of the people, although sheep-farming is being encouraged. Sheep have been brought over from Iceland, where conditions are almost similar. In winter the animals are fed on a mixture of hay and seaweed. The mining of cryolite, which, like bauxite, yields aluminium, is an important source of revenue. It is the only known supply in the world that is commercially worth mining, and it is found at Ivigtut, a small village of 300 Danes. Greenland exports blue and white fox skins, sealskins and blubber, salted fish, narwhal ivory, and eider-down.

Greenland has always had close ties with North America, and during the Second World War the U.S.A. were granted permission to land forces and to build air bases.

See also Polar Regions.

GUATEMALA, *see* Central America.

GUERNSEY, *see* Channel Islands.

GUIANAS. In its widest sense Guiana means the region on the north-eastern side of South America, between the Orinoco River on the north and the Amazon (q.v.) on the south (*see* Map, p. 415). But more particularly it means the three European colonies which lie side by side along the Atlantic coast of South America, between Venezuela and Brazil (qq.v.). The three colonies are British Guiana, Dutch Guiana (or Surinam), and French Guiana (or Cayenne).

The low coastal plain, extending through all the colonies, is backed inland by the Guiana plateau, which stretches into Venezuela and Brazil. Many rivers descend from the highlands to the ocean, and though they are rapid and are navigable only in short stretches—and then only by small local craft prepared to take considerable risks—they are the only routes through the jungle. This jungle is as luxuriant and picturesque as any to be found in the world. It is the jungle of story-books. Giant trees of many varieties grow thickly together, draped with creepers and vines, their vivid green starred with colour by orchids and other exotic flowers (*see* Tropical Jungles, Vol. II). It is full of wild

THE POTARO RIVER, BRITISH GUIANA
Royal Geographical Society

animals—some of them harmless and picturesque, such as the tapir, the sloth, the ant-eater, and the armadillo; but others, like the jaguar, fierce and dangerous. There are flocks of toucans and parrots, with rich and brilliant plumage, and snakes, such as the bushmaster, the rattlesnake, and the huge anaconda that squeezes its prey to death. The waterways are full of alligators; and there is the iguana, a giant lizard that grows to 6 feet in length.

Inland, foot-hills and terraces lead up to the plateaux, on which to-day graze huge herds of cattle. Farther south are the wild, much broken, high mountains which rise between the Guianas and Brazil. This is a region of forests and waterfalls. From the trees come hardwoods, medicines such as quinine, and balsams such as sarsaparilla and vanilla. The magnificent falls of Kaieteur (q.v.) in British Guiana are made by the Potaro River which plunges over a cliff and falls sheer for 741 feet into a deep ravine. The King Edward VIII Falls, not far from Kaieteur, has an even higher, but not so sheer a drop.

During the first opening up of South America by Europeans, the Guiana region lay as an unexplored no-man's-land between the Spanish

Empire to the north and the Portuguese Empire (afterwards Brazil) to the south. The Dutch, the English, and the French stepped in, lured at first by hopes of gold and precious stones—though they soon found a more practical interest in cultivating sugar-cane. Thousands of negro slaves were brought from Africa to work on the sugar plantations, and great fortunes were made. Indeed, during the Anglo-Dutch Wars of the 17th century, the Dutch thought it a good bargain to keep Surinam and let the English have New York instead. It was not until the Napoleonic Wars that Britain finally won from Holland the land that now forms British Guiana, and that the three colonies, the only remaining European colonies in South America, took their present shape.

The three Guianas are immensely rich and valuable. Brown Demerara sugar is a product of British Guiana, and the three colonies produce coffee, valuable timbers, gold and diamonds, bauxite (the raw material of aluminium), and balata (a kind of rubber). British Guiana is the largest and richest of the three, French Guiana the smallest and least developed. French Guiana is best known for the famous and terrible convict settlement on Devil's Island, just off the coast, where, till 1945, France used to imprison her most dangerous criminals.

The peoples of Guiana are an extraordinary mixture. Most numerous are the hardy negro descendants of the slaves. Next in number come the East Indians, who were brought over from the East Indies to work on the plantations after slavery was abolished. Next come Europeans—British, Dutch, French, and Portuguese. The native American Indians are few in number. There are a certain number of Chinese and Japanese.

Georgetown, the capital of British Guiana, with a population of about 70,000, is the largest town and chief port of call for all three colonies. Its wide, tree-lined streets are gay with brightly painted wooden houses, their verandas draped with scarlet and purple bougainvillea. Tram-cars and motor-cars jostle slow ox-carts in its main thoroughfares. Paramaribo, with a population of about 50,000, is the capital and chief port of Dutch Guiana. Cayenne, the capital of French Guiana, is quite a small town, with about 14,000 people. It is built on an island at the mouth of the Cayenne River.

See also South America.

GUINEA LANDS. These are the territories which border the coast of West Africa along the Gulf of Guinea, from the mouth of the Senegal River to the Belgian Congo (q.v. Map, p. 5). In order, they are Senegal, Gambia, Portuguese Guinea, French Guinea, Sierra Leone, Liberia, Ivory Coast, Gold Coast with Ashanti and the Northern Territories, Togoland, Dahomey, Nigeria, Cameroons, Rio Muni, Gabon, and Middle Congo.

British West Africa includes Gambia, Sierra Leone, Nigeria (qq.v.) with a small part of the Cameroons, and the Gold Coast with Ashanti, the Northern Territories, and a small piece of Togoland. The rest of Togoland, Senegal, French Guinea, Ivory Coast, and Dahomey form part of French West Africa. The Cameroons, except for the small part attached to Nigeria, Gabon, and Middle Congo, are part of French Equatorial Africa (*see* French Africa). Liberia is a Negro Republic; Rio Muni is Spanish.

The coast almost everywhere is flat and bordered by sand-spits behind which lie lagoons and often broad stretches of swamp and marsh. Along the coast from the Ivory Coast to the Cameroons is a broad belt of mangrove swamp. The lagoons give an easy sheltered means of coastal communication, and there are several fine natural harbours, such as Bathurst in Gambia, and Freetown in Sierra Leone. Good

CAPE COAST, GUINEA LANDS

B.O.A.C.

A GOLD COAST VILLAGE. *B.O.A.C.*

harbours have been constructed at Dakar in Senegal, and at Sekondi and Takoradi on the Gold Coast.

Inland a series of step-like terraces rises to the plateau of the SUDAN (q.v.). There are but two mountainous areas. A high range curves southwestwards along the border between Nigeria and the Cameroons, and is continued seaward by the island of Fernando Po, which rises precipitously 9,185 feet above sea-level. The other area is the Futa Jallon highland of French Guinea and its extension in Sierra Leone.

On the coastal lowlands the thick forests, with mahogany, cedar, and ebony trees, have not yet been properly made use of. In the forest clearings, and also inland, there are oil-palms, coconut palms, rubber-trees, and cultivated crops of cotton, maize, rice, cocoa, bananas, and groundnuts. Farther inland, on the higher and drier terraces, there is open woodland.

The oil-palm is important everywhere. Cocoa is the main export from the Gold Coast and Cameroons. Ground-nuts are the chief crop of Gambia and Senegal. Gold, tin, and, to a lesser extent, manganese, are the principal minerals.

The main cities in the Guinea Lands are all ports. Inland, apart from the cities of Kano and Ibadan, there are only villages.

See also AFRICA.
See also Vol. I: NEGRO AFRICANS; ASHANTI.

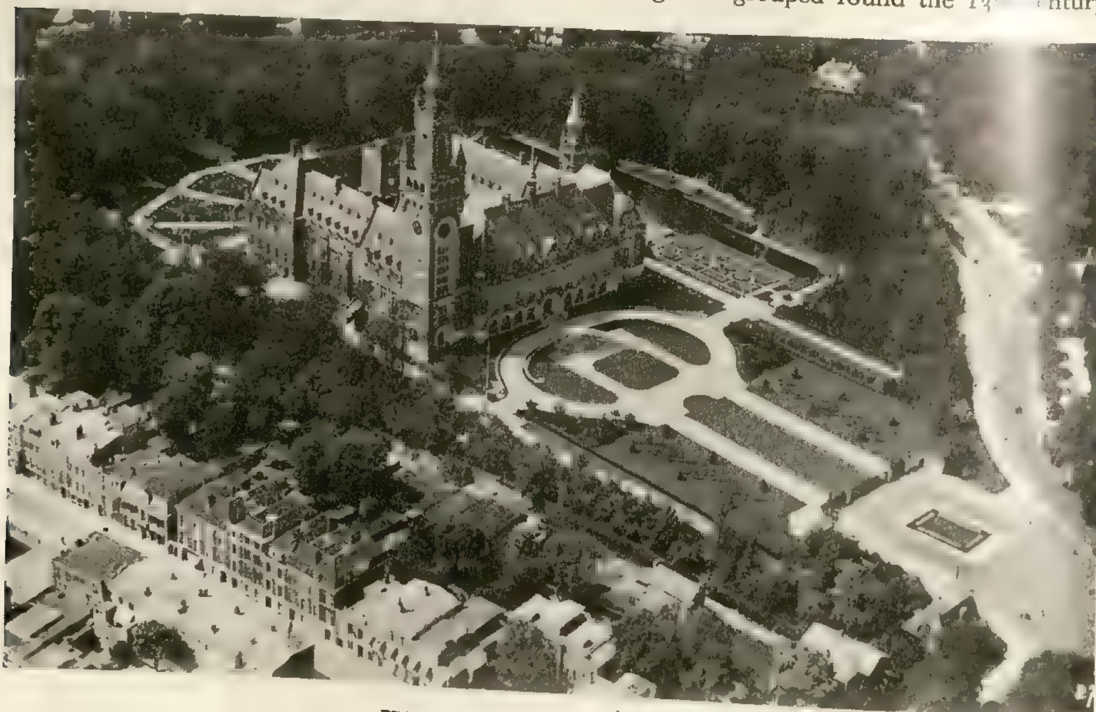
GULF STREAM, *see* OCEANS.

GYPSUM, *see* MINERALS, Section 6.

H

THE HAGUE (in Dutch's Gravenhage or, more commonly, den Haag) is the third largest town in Holland, capital of its richest province, Zuid-Holland, the residence of the court and the seat of the government of the country. The town dates from the 13th century, when it began as a hunting-lodge of a Count of Holland. His son made it his royal residence, so that it became the supreme court of justice in the realm. The Great Hall which he originally built still stands to-day. For a hundred years from the middle of the 17th century The Hague was the diplomatic centre of Europe, and a great number of treaties were signed there. Since 1899 it has be[illegible]e scene of The Hague Convention and of [illegible]us Peace Conferences, for which the en[illegible]us Peace Palace was built in 1913. From 19[illegible] has been the home of the International Co[illegible]f Justice, established by the League of Nati[illegible]nd maintained by U.N.O. In spite of its in[illegible]nce and size, it did not officially become a [illegible] until the French occupied it in the Napole[illegible]ars—so that it was for long known as 'the l[illegible] village in Europe'.

The Hague is of no industrial imp[illegible]ce and, apart from its 'Whitehall' charact[illegible] almost entirely residential, with a very hig[illegible]centage of retired civil servants, colonial ad[illegible]strators, and others. This affects both the c[illegible]ter and appearance of the town, which is c[illegible]vative, well-to-do (one of the richest towns [illegible]urope), and exceptionally clean. The genera[illegible]ression is French rather than Dutch; the [illegible] broad streets are lined with rows of trees a[illegible]e older houses have a cosmopolitan air. [illegible] Dutch towns suggest the 17th century, the [illegible]n age of Holland; but The Hague is a mixtu[illegible] 18th-century buildings and large residen[illegible]istricts of modern design. In the heart of th[illegible]n is a lake, on the banks of which the g[illegible]ment buildings are grouped round the 13[illegible]ntury



PEACE PALACE, THE HAGUE *K.L.M.*

Ridderzaal (Hall of Knights). This forms one side of the square known as the Binnenhof, at one end of which stands the Second Chamber, or House of Commons; and at the other stands the charming small 17th-century palace known as the Mauritzhuis, which now contains a small but very famous collection of Dutch paintings, including many important Rembrandts. On an island in the lake a stork nests every year—a stork is included in the coat of arms of The Hague.

In 1900 the population was 212,211; by 1951 it had reached 570,000, and it is still growing. The expansion is mostly to the south and west, and it has long since joined up with the seaside resort and fishing village of Scheveningen 2½ miles away. The absence of major industries, and the combination of seaside, spacious planning, and surrounding woods, explain why so many people have decided to settle there.

HAIL. If a fairly large hail-stone is split open, it will be found to consist of a central core surrounded by onion-like layers of compact snow and solid ice.

Most hail-stones are formed during severe thunder-storms. During a storm, currents of air are continually rushing to the top of the thunder-cloud which may tower 5 miles high. As the currents rise they carry with them drops of rain which freeze and gather coatings of snow and frost when they enter the higher regions of the cloud. Since the frozen raindrops are heavier, they tend to fall and eventually come down to where they started among the raindrops. Here they gather a fresh layer of water, part of which freezes at once on to the ice-cold kernels. If another powerful up-current of air seizes them they are carried up again and receive another coating of snow and frost. This up and down process continues until the hail-stones are too heavy to be carried up by the up-currents of air. Large hail-stones have been found with as many as twenty-five layers, indicating that they had made twenty-five journeys between the bottom and top of the thunder-cloud.

It is evident that in suitable conditions very large hail-stones may form. Even in this country, stones about the size of tennis-balls and weighing over half a pound fall occasionally. Charles Darwin reported that extremely hard stones the size of small apples fell in a South American hail-storm and killed many animals. Beasts as large as cattle have been battered to death by outsize hail-stones, and even people have been killed. There is a reference to a severe hail-storm in the Book of Joshua. However, such violent storms occur chiefly in countries with a warmer climate than that of Britain. Severe hail-storms can do much damage to farms and to agriculture by smashing glass-houses, ruining crops, and killing poultry. In earlier days people tried to ward off hail-storms by various measures, one of which was to fire special cannon at the clouds; but most meteorologists consider such measures of little or no value.

A startling, yet apparently authentic, phenomenon which, however, occurs but rarely is the descent of small animals such as insects enclosed in hail-stones—they get carried by the up-currents of air just as the raindrops do, and become encrusted with ice and snow.

HAITI, *see* West Indies.

HALO, *see* Rainbow.

HAMBURG. Germany's second largest town, with a population of over 1½ millions, was also the largest commercial port of the European continent. It is situated about 90 miles from the North Sea, up the long narrow gulf made by the River Elbe (*see* Map, p. 186). Merchant ships from Hamburg travelled to all parts of the world, bringing in goods for central Europe and as far inland as Bohemia. The great inland port, with its enormous dockyards, its busy wharves and quays, the nearby streets of old warehouses and modern offices, and the buildings of many auxiliary industries, all unite to give the city an aspect of modern prosperity based on an old tradition. In the Second World War, however, enormous destruction was inflicted upon Hamburg, so that this account is true rather of the pre-war than post-war city.

Hamburg owes much of its individuality and charm to the River Alster, a tributary of the Elbe. Almost in the centre of the town, this river forms a wide basin, made lively with sailing-boats, and bordered by boulevards, gardens, and the big houses of the wealthy merchants. Narrow channels, called *Fleeten,* lead through the heart of the city from the Alster to the Elbe. Several great bridges cross the Elbe, and there is a tunnel for pedestrians and

OLD HOUSES IN HAMBURG
Royal Geographical Society

vehicles underneath it. Impressive modern buildings stand in contrast with the copper-green Gothic spires of the churches and with the old merchant houses. Very large new suburbs, built after the First World War, show some of the best housing in flats to be seen in Germany.

Hamburg is a city with an old and interesting history. Charlemagne built a castle there over a thousand years ago, and it was the starting-place for the conversion to Christianity of the northern peoples and the western Slavs. In the 13th century Hamburg became one of the most important cities of the HANSEATIC LEAGUE (q.v. Vol. VII). This league of northern merchant cities began originally as a guild of merchants combining for the protection of their shipping. By the 14th century the Hanseatic towns had grown so rich and powerful that they played a considerable part in the politics of their time—even to the extent of waging war. When the League began to decline in the 16th century, Hamburg remained a free city with its own Government. In the 18th century it played a great part in fostering German art and scholarship. In 1842 a terrible three-days' fire destroyed almost a third of the city. Now, very little of the medieval Hamburg is left.

See also GERMANY.

HANGING VALLEYS, *see* GLACIERS.

HAWAIIAN ISLANDS, *see* PACIFIC ISLANDS.

HEAT. 1. ITS NATURE. Everyone knows what heat feels like, and knows, too, many of the things it can do; but the problem as to just what heat is puzzled men's minds for thousands of years and was finally solved only about a century ago, by Joule in 1849. Heat is recognized by us because, in anything possessing heat, the tiny particles of which all matter is made are in a state of vibration. If we touch a hot iron, the vibrations in its molecules are transferred to those in our hand—and we feel the sensation that we know as heat. If we touch a hotter iron, the vibration may be so violent that it will actually force out of place some of the molecules that make up the tissues of our finger-tips—and we shall get a blister. If we put a pan of water on the fire and add heat to it, the molecules of the water vibrate more and more violently until the time comes when they can hold together no longer as a liquid—and so they turn into the gas we call steam. If we put water into a refrigerator and take away some of its heat, the molecules vibrate less and less until the time comes when the water turns into ice. Heat, then, is a form of ENERGY (q.v. Vol. VIII). Now without energy of some sort, all forms of life and much other movement and action on the earth would come to a stop. Plants and trees, no less than men and animals, need energy for growing; rain needs energy for its formation; winds and ocean currents are largely moved by heat energy. And the original source of all the earth's energy is the sun, which daily pours more and more out in the form of heat to add to the vast stores that have already accumulated as flowing water, coal, oil, and innumerable other chemical compounds.

2. TEMPERATURE AND SPECIFIC HEAT. If we were asked to say how much heat there was in any particular thing, we might think that we could find out the answer by measuring its temperature with a thermometer. In this we should be wrong. Temperature is a measure of the *level* of heat and not of the *amount* of heat in anything. We can prove this by taking equal quantities of two liquids, such as water and

mercury, at the same temperature and putting equal amounts of heat into each. The temperature of both will rise; but in the case of the water, the rise will be only about one-thirtieth of that of the mercury. Whatever substance we choose (without rare exceptions), we shall find that its temperature rises much more than that of water—in other words, in order to raise the temperature of water, we have to put into it more heat than into any other substance; or, in scientific terms, the 'specific heat' of water is higher than that of anything but hydrogen. The practical results of this in the world around us are very important. If a great deal of heat can be put into water without raising its temperature very much, it stands to reason that the opposite is also true—that water can give off a great deal of heat without dropping very much in temperature. When we put a hot-water bottle in our bed, it gives off a lot of heat for several hours; but if we were to put into our bed a bottle filled with mercury at the same temperature, we should be very disappointed to find how quickly it lost its heat compared with water. All day long the oceans of the world are taking in heat from the sun's rays, taking in far more heat than any other substance could. Then during the night, when the temperature of the air above them falls, they give some of it back, because one of the laws followed by heat is that it always tends to flow back from the warmer to the cooler substance. Similarly, much of the heat accumulated by the seas in the summer is stored up and given slowly back during the winter. That is why the climates of islands like Great Britain are much more even through summer and winter than those of places surrounded, not by water, but by land. Our great hot-water bottle, the ocean, saves us from the extreme cold experienced in winter by many places in Europe and Asia far nearer the Equator than ourselves (*see* CLIMATE).

3. EXPANSION AND CONTRACTION. It is often said that 'heat rises'. This is not true: heat itself moves equally well in any direction, so long as it flows from the hotter to the cooler, and never the other way round. What is true is that the hotter part of any liquid or gas rises above the cooler part. The reason for this is that heat causes almost any substance to expand, and so become lighter in proportion to its size. In fluids the lighter part flows up to the top while the cooler, denser part takes its place below—a process clearly shown by the boiling of a saucepan. When we remember that heat causes molecules to vibrate, it seems only natural that matter should expand when heated—because this means that molecules are made to vibrate more widely, and so occupy more space. A familiar example of expansion and contraction caused by heat and cooling is the thermometer, in which the mercury rises and falls in accordance with changes of temperature. The alternate expansion and contraction of rocks in heat and cold plays a great part in the process by which they are gradually broken down into soil.

The rule that all substances expand when heated is not quite universal, and there is one exception particularly remarkable in its results: when heat is applied to water at freezing-point, for the first few degrees of rise in temperature the water contracts instead of expanding. Water, then, is densest or heaviest, not at freezing-point, but a few degrees above. In consequence of this, just before a lake reaches freezing-point in winter, it is the *hotter* water which sinks to the bottom, allowing the ice to form on the top. If it were not for this extraordinary exception, lakes and even the sea might freeze down to the bottom in winter, and all the heat of summer—mainly applied at the top, as it is, by the sun and warm air—might not be enough to thaw them again. The relation between the temperature, pressure, and volume of gases is described in PRESSURE (q.v.).

4. TRANSMISSION OF HEAT. Heat is transmitted in three ways—by conduction, convection, and radiation. It has already been said that heat always flows from the warmer to the cooler. If one part of anything is heated, the heat spreads through the actual matter until it reaches the other parts. It is as though the vibrating molecules in the hotter part jostled their neighbouring molecules and so passed on the vibration from one to another. This movement of heat is called conduction. All materials are able to conduct heat to a certain extent; but some are very much better conductors than others. Metals are particularly good conductors. If the ends of two rods, of iron and of wood, are held in the fire, heat will very quickly travel along the iron rod, soon making it too hot to hold; whereas the wood in the same time will not have got noticeably warmer. The various objects in a room all reach the same temperature as the air in it after a time; but if we touch a piece of metal in it, this will feel much colder to

us than, say, a piece of wood. The reason for this is that the metal, being a good conductor, leads the heat of our hand away very quickly, so that we feel the sensation that we call 'cold'; but the wood, a poor conductor, leaves most of the heat still in our hand, and we feel it as warm.

Convection is the transmission of heat by the actual flow of the liquid or gas heated. It has already been explained above in Expansion and Contraction. The hot-water or steam 'radiators' used for heating houses should really be called 'convectors', since most of the heat they supply is convected, not radiated. In the natural world convection is immensely important since it is the cause of the main winds and ocean currents of the world, as well as of more local effects, such as CLOUDS and THUNDER-STORMS (qq.v.). In Great Britain, with its variable climate, we hardly realize that there are great areas of the world where at certain times of the year certain winds blow for months on end in the same direction (*see* WINDS). These are convection currents, caused by the hot air from the Equator rising and being replaced by colder air sweeping under them from the Poles. In the same way there are fixed ocean currents, caused by the flow of water heated in the tropics or chilled in the polar regions. The Gulf Stream, which warms the British Isles, is an example of this.

The kind of heat which reaches us from the sun must clearly be quite different from all we have discussed so far, although its effects are much the same when it gets here. But in the great emptiness of space it has to cross, there are no atoms or molecules to pass on the vibrations by conduction, nor are there fluids to carry heat by convection. Neither conducted nor convected heat can travel through space or through a vacuum (as is shown by the way a vacuum flask will keep tea hot). Radiant heat, which can, is a form of radiation precisely similar to light, X-rays, and wireless waves, except that its wave-length is different. It is described more fully in the article on RADIATION (q.v.). After the sun, perhaps the most familiar example of radiant heat is a bright open fire—for it must not be thought that this form of heat is found only in outer space: it can pass through air, glass, and many other substances.

Radiant heat can be focused and reflected and treated in every way just like light, and, like light, it is stopped by some substances, but can travel straight through others. Light, as we know, can travel through water; but radiant heat cannot—the water stops it. Here is yet another example of an unexpected property of water which makes life on earth possible. Not only water, but water-vapour transmits radiant heat very badly—and there is always a large quantity of water-vapour in the atmosphere. If it were not for this screen of vapour, the terrible heat of the sun would beat down during the day and scorch up everything living. During the night the earth itself would radiate this heat back into space so quickly that the temperature would fall below zero all the year round. This is what happens on the moon, where no water exists. As it is, thanks to water-vapour we are spared the full heat of the sun and enabled to keep a good proportion of the comfortable heat we have gained. But this is not all we owe to water: when the passage of radiant heat is stopped by anything, that thing itself must take up the heat energy of the radiation and become warm with conducted heat. Water, as we have seen, can take in a large amount of heat, and thus it is mainly by radiant heat that both sea and air are warmed.

5. LATENT HEAT. This phrase means simply 'hidden heat', and the opposite to it is 'sensible heat'—heat that can be felt (or sensed). When a substance changes its state from a solid to a liquid, or from a liquid to a gas, a great deal of heat must be given to it; but until the change of state is quite completed—the last bit of ice melted or the last drop of water evaporated—the temperature does not rise, as we might expect: the heat is just swallowed up and hidden. Petrol or methylated spirit feels cold on the hand because, as it evaporates (which it does quickly), it needs a lot of heat to complete its change of state, and this it takes from our hand. For the same reason we are apt to catch cold from wearing damp clothes. It is not difficult to understand the reason for latent heat when we realize that in a liquid the molecules are more free to move than in a solid, and that in a gas they are far more free still—that they are, in fact, constantly moving about very rapidly. To make the change from one state to another, then, they must have more energy to increase their movements, and this they take in the form of heat. When a substance changes from a gas to a liquid, or from a liquid to a solid, the latent heat is given up again. This is why a pond which has reached freezing-point still takes

A CROFT ON HARRIS, OUTER HEBRIDES
Topical Press

a long time to ice over: all its latent heat must be given off into the air before ice can begin to form. Other examples of the effects of latent heat are given in CLOUDS and THUNDERSTORMS (qq.v.).

See also MATTER.
See also Vol. VIII: ENERGY.

HEATH, *see* MOORLAND AND MARSH.

HEBRIDES. The west coast of Scotland is bordered by two arcs of islands, separated from each other by the Gulf of Hebrides and the Little Minch (*see* Map, p. 396). The inner arc, or Inner Hebrides, curves northwards from Islay in the south to Skye, which is the best known of the Islands. The outer arc, or Outer Hebrides, stretches from the Butt of Lewis in the extreme north of the big island of Lewis and Harris to Barra Head in the extreme south. The Outer Hebrides are sometimes called the Long Island, for they form a confused pattern of low, hummocky islands, separated by many lochs and channels, and, except in north Harris, rising rarely as high as 500 feet above sea-level.

All the islands have been scoured and fashioned by ice action (*see* GLACIATION). In Skye and Mull the corries, steep-edged peaks, and deep U-shaped glens are world-renowned for their beauty and grandeur. Most of the other islands have been worn away into rocky undulating plateaux that fall in many places to the sea by steep cliffs.

The people of the Hebrides are crofters and fishermen—usually both. They keep sheep, till a small plot of land, and fish off the coast. Their low houses—low as a protection against the strong winds—are usually within sight of the sea. Some of the men work with the herring fleets that follow the shoals round the coasts of Britain. Stornoway in Lewis and Castlebay in Barra are herring ports. The islands are famous for their wool and tweeds. Much of the wool is hand-spun and hand-woven, and the beautiful soft colours of the tweeds are still to a great extent the result of the use of vegetable dyes.

Practically all the islanders are bilingual—speaking English as well as Gaelic; but Gaelic is the language of their songs, set to haunting and plaintive tunes, and their folk-tales are told

KANCHENJUNGA FROM DARJEELING
Royal Geographical Society

by story-tellers in Gaelic. Many of the islands have strange-sounding names such as Eigg, Rum, Muck, Uist, and Vatersay. Most of these are of Norse origin, a relic of the times when the Viking sailors visited the Hebrides.

HELSINKI, *see* FINLAND.

HERZEGOVINA, *see* YUGOSLAVIA.

HIMALAYAS. The intricate and complex system of folded mountains that forms the northern boundary of India from Afghanistan to Burma is called the Himalayas. The word 'Himālāya' means 'Abode of Snow'. The main range, the Great Himalaya, which is 1,500 miles long, forms an arc, 20,000 feet high, snow-covered and with sharp clear-cut peaks that shine brilliantly in the rarefied clear air. This range, which runs in the main from north-west to south-east, is bounded by the INDUS River (q.v.) on the west and by the Brahmaputra on the east (*see* Map, p. 229). It contains some of the highest peaks in the world, Mt. Everest (29,002 feet), Kanchenjunga (28,146 feet) towards the east, and Nanga Parbat (26,620 feet) at its western end. There have been eleven major expeditions since 1921 attempting to climb Mount EVEREST (q.v.); and in May 1953 two members of a British expedition reached the summit. Some idea of the force of the wind at their summits is given by the fact that the 'snow plume', or trail of ice particles blown off by the wind, can be seen on clear days from the outer hills 50 miles away. The Great Himalaya is built of granites, gneisses, and ancient sedimentary ROCKS (q.v.). It makes a climatic break between India and central Asia, for the rain-bearing winds of the south-west Monsoon rarely cross the Range into Tibet, nor can winter winds from north Asia reach India.

To the south the line of the Lesser Himalayan and Siwalik Mountains is parallel to the Great Himalaya, which they separate from the great plain of northern India. Both are sedimentary: the Siwaliks, in which are found fossils of mammals, having been upheaved in comparatively recent times (*see* MOUNTAIN BUILDING). In the western part of the Himalayas, in Kashmir, the mountain system becomes more complex: a further three parallel ranges, the Zaskar, Ladakh, and Karakoram Ranges, stretch to the north of the Great Himalaya, and are separated from each other by deep valleys scoured out by

the tributaries of the Upper Indus. The Karakoram extends eastwards into TIBET (q.v.), the highest country in the world, and westwards into AFGHANISTAN (q.v.), where it is called the Hindu Kush. It forms an arc 1,000 miles long, concave to the south, and thus curved in an opposite direction to the Great Himalaya. Mt. Godwin Austen (28,250 feet) is the highest peak in the Karakoram. The comparatively easy Karakoram pass, 18,000 feet high, carries the trade-route from Leh, in Ladakh, through Tibet to the Sinkiang province of China. The passes over the Hindu Kush are lower, and have been crossed many times in history by peoples driven from the steppes of Asia.

The Great Himalaya forms only a partial watershed, drained on its northern side by the Upper Indus and Brahmaputra (known in Tibet as the Tsangpo). Rising near together midway along the range, these flow in opposite directions parallel to the line of high peaks, and then cut southwards to enter the Great Plain of northern India, the Indus at the north-western and the Brahmaputra at the south-eastern end of the range. South of the Great Himalaya flow transverse rivers, such as the five main tributaries of the Indus, the Ganges with its south-flowing tributaries, and the tributaries of the Brahmaputra. Some of these rivers issue from ice caves at the ends of mountain glaciers; others, such as the Sutlej, drain large areas to the north of the Great Himalaya. To the east, the IRRAWADDY (q.v.) has its source in the Himalaya, while the Salween, the Mekong, and the YANGTZE (q.v.) bend round the Eastern Himalaya in parallel courses, and have their sources in Central Tibet.

The valleys to the north of the Great Himalaya are dry and infertile; but those south of it are well watered by the monsoon, and the natural vegetation changes from sub-tropical to temperate rain-forest, coniferous, and alpine, as the snow-line is approached. The most fertile part is in the east, where the MONSOON (q.v.) gives plenty of rain. In the eastern Himalayas tea is grown on the hills near Darjeeling (7,000 feet). In the outer hills are hill-stations like Mussoorie, Simla, and Darjeeling, where many spend the hot season away from the heat of the Indian plains. From these hill resorts there are unrivalled views of the panorama of snow-clad high peaks of the Great Himalaya. The Vale of Kashmir, deep in the Himalayas, attracts tourists from all over the world. It is especially famous for its wild mountain flowers and fruit-trees. It is watered by the Jhelum River which forms many placid lakes.

The Himalayas have a magnificent variety of plant and animal life, ranging from arctic and sub-arctic types to dwellers in hot tropical forests. Rhododendrons flourish from about 7,000 feet to about 14,000 feet; and above the line of the forests is found a wonderful range of ALPINE FLOWERS (q.v. Vol. II). From about 6,000 to 8,000 feet, there are many types of orchids. To the Himalayas, too, belong some of the most gaudy and enormous butterflies and moths in the world (*see* BUTTERFLIES AND MOTHS, TROPICAL, Vol. II), as well as many birds and other animals.

See also ASIA; INDIA; NEPAL; TIBET.
See also COLOUR PLATE opposite p. 224.

HINDU KUSH MTS., *see* AFGHANISTAN.

HOBART, the capital of Tasmania, is one of the oldest of Australia's state capitals. It is a quiet little city of just over 87,000 people, beautifully situated at the foot of Mt. Wellington on the Derwent River, about 12 miles from the sea.

Hobart was founded as early as 1803, but by 1812 there were still only 150 houses—and these little better than huts. In 1813, however, the ban on coastal trade from ports other than Sydney was lifted, and Hobart grew rapidly as a trading port. By 1821 it possessed 420 solidly built stone houses. One of the first banks in Australia, the Van Diemen's Land Bank, was founded there in 1823.

Hobart's prosperity depended on the wool from Tasmania's sheep-farms, and, even more, on the Antarctic whaling and sealing industries. Her port was frequented by hundreds of ships, many built in her own shipyards, others from as far afield as the eastern U.S.A. Their cargoes brought activity and prosperity to the merchants of the town, wool, whale-oil, and sealskins being exported to many parts of the world. By the middle of the century, all the seals had been killed and the whales had moved to other grounds; the lead in wool-growing had been taken by the mainland, and, with the discovery of gold, many of the most enterprising young people were drawn off to the 'diggings'. The port was deserted, and Hobart lost its importance.

To-day it thrives largely as the centre of a district of rich farms and orchards. Its most

HOBART FROM ACROSS THE HARBOUR WITH MT. WELLINGTON IN THE BACKGROUND
Dorien Leigh

important crop is apples, which it exports to the mainland and to England. Strawberries and other cold-climate fruits grow very well also, for the climate is much like that of the home-country. Hobart's old-world picturesqueness, with its square sandstone houses, built by convict labour, its horse-cabs, and the natural beauty of its surroundings, make it a favourite tourist centre for people from the Australian mainland, to which it presents such a contrast. It is famous, too, for its private schools, at least two of which, the Friends' School and Hutchins, both over 100 years old, are well known throughout Australia.

See also AUSTRALIA.

HOKKAIDO ISLAND, *see* JAPAN.

HOLLAND. Another name for Holland is The Netherlands. It is a very flat, low-lying country built of the sediment brought to the North Sea by the RHINE (q.v.), the Maas or Meuse, and the Schelde (*see* Map, p. 160). Part of west Holland is actually below sea-level, and about half is no more than 1 to 3 feet above. The only part where there is high land is in the extreme south near Aachen, where the northern edge of the Ardennes rises to about 1,000 feet above sea-level.

The coast is fringed by low islands and sand-banks, and by dunes from 30 to 100 feet high.

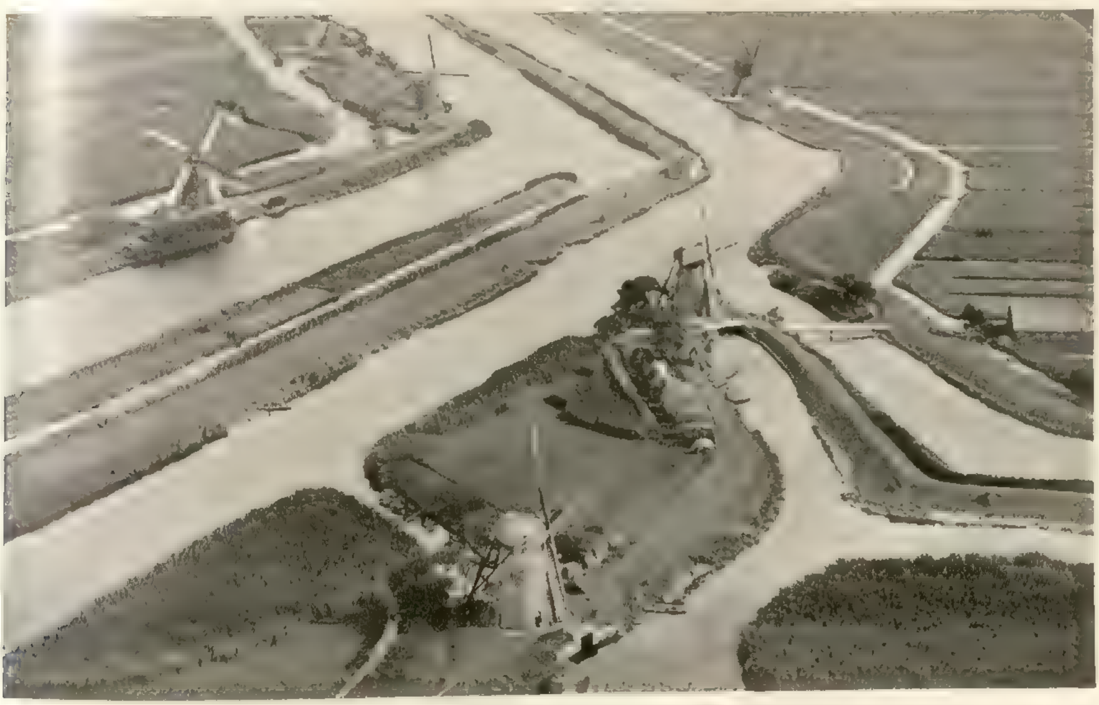
Behind the dunes there used to be broad, shallow lagoons and stretches of marsh; but now thousands of acres have been reclaimed by the building of sea-walls and dykes, the pumping of the water, and the cutting of canals. The same draining works are now being carried out on the Zuider Zee, the vast lagoon north-east of Amsterdam. The dykes are huge, massive constructions many yards broad, with roads running along their tops. The *polders*, as the reclaimed areas are called, make excellent agricultural land. Dairy cattle are reared, yielding milk, cheese, and butter for export; cereals, sugar-beet, flax, and vegetables are grown. In spring and early summer, as the bulb fields blossom into brilliant reds, oranges, whites, and yellows, the country-side, especially round Haarlem, is a riot of colour.

Inland from the polders there is sandy heath land, with here and there peat-bogs and sand ridges. The poorest sandy soil is usually planted with pine-trees to hold it in place, but many areas of peat and heath have been recovered for agriculture by draining and fertilizing. Cattle, pigs, and poultry are reared on such land, and potatoes, rye, oats, and vegetables grow well.

Along the coast are many small fishing villages and it is there that the old Dutch costume of baggy trousers or full skirts and wooden shoes is still to be found.

The only mineral wealth possessed by Holland is coal in the Limburg field in the south. Most of the industry of Holland depends for its raw materials on imports from the EAST INDIES (q.v.) and from the Dutch colonies in the WEST INDIES (q.v.) and on materials brought up the Rhine. Manufactures include margarine, cocoa, tobacco, cotton and woollen goods, artificial silk, boots and shoes, electrical equipment, machinery, cement, paper, and glass.

AMSTERDAM (q.v.), the largest town and the commercial centre of Holland, is on the shallow Zuider Zee. Itself an important port, it is connected by a ship-canal to its outport of Ijmuiden. Rotterdam, the second largest city, is the chief port of Holland and one of the great ports of Europe, for through it passes much of the trade of the Rhineland. It has big shipyards, and is connected by ship-canal to the North Sea at Hook of Holland. Its manufactures include cocoa, margarine, and tobacco. Like Amsterdam, it had many picturesque streets and



WINDMILLS AND CANALS IN HOLLAND

K.L.M.

houses—but Rotterdam suffered terrible damage from air-raids in the Second World War. The administrative capital of Holland is THE HAGUE (q.v.), reputed to be one of the wealthiest cities in the world.

In northern Holland the absence of rock or of any other firm sub-soil for foundations has caused architects and builders many constructional problems. In some towns, especially in Amsterdam and Rotterdam, houses are built on pile foundations. The levels of some streets sink every few years and have to be restored by building a new surface on top.

See also Vol. I: DUTCH.

HOLSTEIN, *see* SCHLESWIG-HOLSTEIN.

HONDURAS, *see* CENTRAL AMERICA.

HONG KONG. About one-sixth the size of the Isle of Man, Hong Kong lies off the coast of China at the mouth of the Si-kiang River (*see* Map, p. 87). Great Britain acquired the island in 1841, after the First China War. At that time a trading place was needed where there could be freedom from the crippling restrictions imposed by the Chinese upon foreign trade; and this rocky islet suited our purpose excellently.

In a hundred years Hong Kong has become the greatest 'free port' in the world. The great liners heading for Shanghai and Japan call there; and there, ships from all quarters of the globe land their cargoes to be carried on by other vessels to markets all over the Far East. Where, a century before, only a few fishermen's families existed, there has grown up a population of $2\frac{1}{4}$ million Chinese and some 10,000 other races, of whom the Europeans are mainly British. To-day Hong Kong is the principal British naval base in the Far East.

Few sights equal in beauty the view of Hong Kong from a ship lying in the harbour. Victoria, the city of Hong Kong Island, stretches for 5 miles along the narrow water-front and climbs up the thousand-foot peak which rises immediately behind. At night the peak looks like a huge illuminated cone, towering up from the harbour. From the top there is a magnificent view across the South China Sea, with its myriad tiny islands. The Portuguese, the first Europeans to visit the China Sea, called these the 'Thieves' Islands', because of the pirates who infest them, even to-day.

The colony of Hong Kong extends on to a small piece of the mainland called Kowloon, a suburb which provides additional space for docks and factories. Behind Kowloon are the 'Leased Territories', 350 square miles of open territory leased from the Chinese in 1898 to improve the defences of Hong Kong.

See also CHINA.

HONOLULU, *see* PACIFIC ISLANDS.

HONSHU ISLAND, *see* JAPAN.

HUMIDITY, *see* WATER-VAPOUR.

HUNGARY. This central European country is divided into two almost equal halves, east and west, by the DANUBE (q.v.). Its most striking feature is the great flat plain which lies on both sides of the river. Eastwards this continues into Roumania and southwards into Yugoslavia; westwards it stretches to the plateaux north and south of Lake Balaton, and northwards to the foot-hills of the Carpathian mountains, where grow the vines which produce 'Tokay', one of the most famous wines in the world (*see* Map, p. 160).

The plain of the middle Danube has been described as 'an ocean of dry earth'. There are few hedges or trees, except along the swampy borders of the bigger rivers and round villages and farms. In some areas the soil is so salt and sandy that it can be used only for pasture. The Hungarians call such areas *puszta* (which means 'waste'), and on them are pastured white Hungarian cattle—a breed able to stand great heat and drought and also very suitable for draught animals. The whole plain used to be pasture land for horses, sheep, and cattle, but now most of it grows wheat and maize, melons, paprika (very much used in Hungarian cooking), and in some places tobacco. Cattle are kept in stalls, and pigs and geese are fed on grain.

The long, narrow Lake Balaton, much loved by Hungarians, is the largest lake in central Europe. Though over 50 miles long, it is nowhere more than 36 feet deep. The people of the villages along its shores used to depend largely on fishing for their livelihood. Now the most important industry is catering for the thousands of holiday-makers who throng there in summer. North of Lake Balaton the land rises steeply to the high plateau of the Bakony Forest, most of

WATERING HORSES ON THE HUNGARIAN PLAIN
E.N.A.

[illegible] is wooded with deciduous trees. To the s[illegible] of the lake there is a lower, very fertile pl[illegible]au, broken by two blocks of granite hills. He[illegible] wheat, rye, potatoes, and fodder crops are [illegible].

[illegible]ngary is mainly an agricultural and pastoral country. She has very little mineral wealth and, consequently, no very large industrial centres. Flour-milling is the most important industry, especially in Budapest, where sugar milling, and textile, machinery, and tobacco industries are also concentrated. The country has very many beautiful old towns, some of them dating back to the days of Roman settlements. The capital, BUDAPEST (q.v.), used to be, before so much was destroyed, one of the most lovely cities of Europe.

See also Vol. I: HUNGARIANS.

HURRICANE. The word 'hurricane' is derived from the Carib Indians' name for their god of stormy weather, Hunraken. And a hurricane is a certain type of very violent storm, other names for which are typhoon and cyclone—though the last is used also to describe an area of low atmospheric pressure (*see* WEATHER).

Before a hurricane can form, there must be heat, moisture, calm air, and a vast twisting movement. The first three of these conditions are best satisfied over the calm oceans in the doldrums, the equatorial belt of calms between the north-east and south-east trade winds. A deflective force is derived from the vast twisting movement of the rotation of the earth. This is not sufficiently great at the Equator to develop hurricane winds, and hurricanes usually form when the doldrums are to the north or to the south of the Equator.

A hurricane is formed by winds sweeping round in a coil of decreasing circles. It is shaped like a gigantic disk, some thousands of feet thick, with a diameter of about 500 miles.

In the centre of the disk there is almost always a calm area called the 'eye'. An object caught up in a hurricane is whirled round and round till it reaches the 'eye' and there it is held till the storm subsides. A hurricane moves like a top—it travels across the sea at a speed which is usually about 12 miles per hour, though it may be much faster, and at the same time the winds forming it whirl round at a speed which is believed to reach 250 miles per hour. No one

A CLOUD TYPHOON IN ECUADOR
Royal Geographical Society

knows the maximum speed of these winds, but they are not as fast as the winds in a TORNADO (q.v.).

To be caught in a hurricane is a terrifying experience. A yachtsman called Weston Martyer who was caught in an Atlantic hurricane wrote: 'Do you know that you cannot breathe with a hurricane blowing full in your face? You cannot see, either: the impact on your eyeball of spray and rain flying at over 100 miles an hour makes seeing quite impossible. You hear nothing except the scream and booming of the wind, which drowns even the thunder of the breaking seas. And you cannot move except by dint of terrific exertions. To stand up on deck is to get blown away like a dead leaf. You cannot even crawl: you have to climb about, twisting your arms and legs around anything solid within reach.'

In 1934, during a terrible typhoon in Japan, ships of over 2,000 tons were lifted over sea-walls and left stranded in streets, and in 1945 an American cruiser in Japanese waters lost its bow in a typhoon in which the wind was said to reach nearly 140 miles per hour.

Luckily all hurricanes do not reach land, but those that do cause great destruction. The winds blow down all flimsily built structures, damage buildings, fell radio masts and trees, and generally cause much havoc. Torrential rain and tidal waves often accompany hurricanes, and are also very destructive. The whirling winds suck up great quantities of water-vapour as they pass over the ocean. This falls later in the form of torrential rain and sometimes in what are popularly called 'cloud-bursts'. In Britain a rainfall of 1 inch in 24 hours is considered heavy: a hurricane sometimes causes 1 inch to fall each hour for 24 hours.

Tidal waves—more accurately 'storm waves' as they are not tides in the usual sense of the word—result when the suction power and driving force of the winds cause waves to rise far above normal level. They dash against the shore at speeds of up to 40 miles per hour, and sweep inland over all but the highest and most sturdily built sea-walls, adding further chaos to that already caused by wind and rain. During a terrible hurricane in the Bay of Bengal in October 1737, waves 40 feet high destroyed thousands of ships and killed over a quarter of a million people. Most tidal waves, however, are caused, not by hurricanes, but by earthquake movement under the sea (*see* EARTHQUAKE).

To-day the danger from hurricanes is not so great. People and ships are warned of their approach by radio, telephone, and even by messages dropped from aeroplanes. Sea-walls are stronger, and buildings are, on the whole, more strongly built. Nevertheless, a large hurricane crossing a built-up area always causes much damage and loss.

But even hurricanes can do good at times. The heavy rains revive crops and replenish water-supplies. Fruit and flowers sometimes blossom a second time—in 1752 in Charleston trees which were stripped of their leaves in September blossomed and bore fruit again in the late autumn. And hurricanes are often followed by very lovely sunsets.

HWANG HO RIVER, *see* YELLOW RIVER.

I

IBERIAN PENINSULA, *see* SPAIN.

ICE, *see* FROST; GLACIERS; ICEBERGS.

ICE AGE. The Great Ice Age affected the whole world. It began more than half a million years ago, at the end of the Pliocene period (*see* Chart with EARTH, HISTORY OF), and is usually regarded as having ended 8,700 years ago, when the Scandinavian Ice-sheet had retreated to central Sweden. There were four cold periods, separated by three warm or 'genial' periods, when the glaciers drew back into the mountains. It is possible that we are living in another 'genial' period and that some thousands of years hence glaciers will again creep down the mountains, covering their wooded slopes and the fertile fields beyond with scores of feet of solid ice.

Many theories have been put forward to explain the cause of the Great Ice Age and its three warm interludes; but as not one of them satisfies all the facts, none can be accepted. It is known that for scores of millions of years before the Pliocene period, the climate of the world was warmer than it is to-day. It is known, too, that there was at least one earlier Ice Age, for evidence of it has been found in the coal-bearing deposits of the southern hemisphere.

There is plenty of evidence of GLACIATION (q.v.), by which we can trace the extent of the Great Ice Age. To-day ice-sheets cover the whole of the Antarctic continent and the greater part of Greenland throughout the year, while small ice-sheets, known as 'ice-caps', cover other parts of the northern hemisphere—as in Iceland and Spitzbergen and in northern Canada and Alaska. But during the Great Ice Age, 30,000 years ago, an ice-sheet extended as far south as the middle of North America; while in Europe an ice-sheet covered the whole of Scandinavia and stretched as far south as the great plain of Europe that extends from northern France eastward into the U.S.S.R. A small ice-sheet, covering Scotland and northern England, had its southern boundary across the Midlands; and all Ireland was covered by ice. In central and southern Europe great glaciers spread northward and southward from the mountains of Switzerland in great sheets on to the lower land.

There is abundant evidence, too, that during this period the climate was cooler all over the world. For instance, in New Zealand there was an ice-cap, of which the great glaciers of to-day are but the shrunken remnants; in Australia there was ice on the mountains of New South Wales and there were glaciers even in Tasmania. In South America, Patagonia was covered by an immense ice-sheet, and in the Andes the ice came down some 4,000 feet lower than to-day; in Africa the glacier of Mount Kenya (17,040 feet), which now ends at 15,400 feet, formerly extended as low as 10,000 feet above sea-level, or even lower. In India and Tibet there is proof that the ice of the Himalayas is but the comparatively insignificant remains of a mighty ice-sheet.

THE EXTENT OF THE ICE-SHEET DURING THE ICE AGES
After W. J. Sollas, 'Ancient Hunters', Macmillan

LAYERS OF SAND AND CLAY DEPOSITED IN THE ICE AGE IN CZECHOSLOVAKIA

From F. E. Zeuner, 'Dating the Past', Methuen

Equally positive is the means by which the end of the last glacial period is dated. This knowledge results from many years of patient work by Swedish geologists. They discovered that when the European ice-sheet began to retreat, its southern boundary was marked by vast lakes into which, every spring, the melting ice poured its streams. These streams brought to the lakes sand and clay. The sand settled down at once; but the muddy clay remained suspended in the water—some of it until winter set in and a layer of ice formed on the lakes. Then, since the water was undisturbed by wind or by inflowing streams, the fine sediment slowly sank to the bottom, forming a thin layer of dark clay. Thus each year a layer of sand and a layer of dark clay were deposited. By tracing the deposits northwards the whole series of years has been recorded. The lengths of the genial periods have been worked out by the extent to which the beds have 'weathered' (*see* DENUDATION). That they were warm is indisputable, for in the deposits of the genial periods are found the bones of animals that can live only in warm regions, the stone and bone implements of men, and the leaves of warmth-loving plants. For example, whereas on the fringes of the ice-sheet there roamed the hairy elephant, in the beds of the interglacial periods there are found the teeth of hairless elephants which must have needed warmer conditions (*see* FOSSILS *and* PREHISTORIC ANIMALS).

See also EARTH, HISTORY OF; GLACIATION; CLIMATE.

ICEBERGS. These are floating masses of ice that have broken away either from the polar ice-fields or from GLACIERS (q.v.) projecting into the polar seas, as in Alaska and Greenland. They often drift for hundreds of miles from their place of origin, and when they reach trade-routes may become a great danger to shipping—more especially since the air around them may become chilled below dew-point, so that their presence is hidden in FOG (q.v.).

Seen in bright sunlight an iceberg can be of entrancing beauty, towering up dazzling white, perhaps 250 feet into the air, with caves and cliffs of every fantastic shade of blue and green. Down its sides in torrents and cascades pours water released by the heat of the sun, while occasionally great masses of ice may detach themselves from above and thunder downwards, to plunge into the sea. Sometimes the whole berg may slowly capsize, raising vast waves, as the warm sea melts away the under-water portion. At such times one can realize that, enormous as the visible bulk is, the part beneath the sea is still

AN ICEBERG OFF THE COAST OF NEWFOUNDLAND

Royal Geographical Society

By courtesy of the artist

THE HIMALAYAS IN KASHMIR
Water-colour by M. L. Milne

A FISHING TOWN ON THE NORTH COAST OF ICELAND. *L. Lockhart*

are huge—for only one-ninth of the whole shows above the surface.

ICELAND. This island outpost of Europe was probably the Ultima Thule of the Ancients. It lies with its northernmost point within the Arctic circle, on the great submarine ridge that runs from Scotland to Greenland (*see* Map, p. 346). Less than a quarter of the island is habitable, the rest is a desert of lava flows, volcanic ash, and glaciers—for about 100 volcanoes rise from it, Mount Hekla being the best known. When volcanoes erupt beneath the glaciers, of which there are many, the sudden melting of ice causes floods which may devastate the country-side. Among other signs of volcanic activity there is the Great Geyser, outside Reykjavik, the capital, and there are numerous hot springs, some of which are used to provide central heating in the houses of Reykjavik, Akureyri, and other towns. The climate is relatively mild, as the island is washed on the south by the warm waters of the Gulf Stream Drift, but is very wet—especially in the east. In summer the nights are short, and in winter the Aurora Borealis (q.v.) often lights up the sky. Iceland is the storm centre of the northern hemisphere, as it lies where the depressions that cross Europe develop. Violent winds sweep so often across the land that there are few trees except small birches, mountain ashes, and willows growing in sheltered parts. There are many species of flowering plants.

Thule or Iceland was long known to the Irish and Scots. As early as 325 B.C. they gave Pytheas, the Greek navigator, sailing directions to it, and we know that Scottish and Irish Celts were living in Iceland when the Norsemen began to colonize it in the 9th and 10th centuries. These Norsemen called the island 'Island' or Iceland because of the snow-fields they could see from the fjords. In 874 Ingolfur founded a settlement where Reykjavik is to-day; and in 930, in the rocky gorge of Thingvellir, the Althing, first of all Parliaments, began its annual session. Perhaps the most outstanding exploit of the Icelandic Vikings, as told in the Sagas (q.v. Vol. I), was the discovery of Greenland and North America in the 10th century.

Iceland to-day has a population of about 144,000, and since 1944 has been a Republic, ruled by a Cabinet of three, responsible to the Althing, which is composed of an Upper and Lower House of 52 elected representatives.

Before this it had been for some centuries under Norway, and then Denmark. The University of Reykjavik was founded in 1911, and there is a fine National Library. Illiteracy is unknown, and even in remote farm-houses books can be found in three languages, Icelandic, Danish, and English. There is a great interest in art, and the modern, colourful landscape paintings of Kiarval are well known. A National Broadcasting Station, opened in 1930, helps to link the country with Icelandic settlements in Canada.

The Icelandic people are great individualists and, like the Scots, are slow to show friendliness and slow to take offence. They follow the traditional occupations of sheep-farming and fishing, and in the country the social event of the year is the bringing of the flocks down from the mountains at the first fall of snow. Wool is spun and woven locally, and the native tweed, *vaomal*, is thick and warm. Sheep-skins, wool, and frozen mutton are exported. In the villages the women sometimes wear their national dress with its gilt ornamented bodice and velvet tasselled cap.

Although many villages are linked by motor-bus, the most usual form of travel is on horseback. The horses are small and similar to Shetland ponies—there are two ponies to every inhabitant of Iceland.

The fishing industry employs about half the population, and much salted cod is exported, particularly to the Catholic countries of southern Europe. The rich fishing-grounds off Iceland are visited by Danish, British, Norwegian, French, and Dutch fishing fleets. Trawlers are built at Hafnafjord, and there is a School of Navigation at Reykjavik.

During the war of 1939–45 Iceland was occupied by British and American forces. It became an important meteorological base and a supply depot on the northern convoy route. A British naval base was built at Hvitanes, and American influence can be seen in the window displays of the shops in Reykjavik's main street. Reykjavik, the capital, has a population of about 57,000.

See also POLAR REGIONS; GEYSERS.

IDAHO, *see* UNITED STATES OF AMERICA.

ILLINOIS, *see* UNITED STATES OF AMERICA.

INDIA. The sub-continent of India is enormous. In it live one-fifth of the world's people. On the north it is bounded by the great mountain ranges of the HIMALAYAS (q.v.), which cut it off from the rest of Asia, while southwards it extends as a peninsula into the Indian Ocean to within 10° of the Equator. From Peshawar in the north to Cape Comorin at the southern tip, India is 2,000 miles long, and at its widest part, from Karachi to Calcutta, it is 1,400 miles across. To travel by rail from the north to the south takes six days and nights. Since August 1947 India has ceased to be a single political unit, and is now split into the Republic of India, whose population is predominantly Hindu, and the Dominion of PAKISTAN (q.v.), with a predominantly Moslem population.

Owing to major differences in relief, climate, and soils, India is a country of extremes. From north to south the three main physical divisions are: (*a*) the Himalayan mountain region; (*b*) the plains of the Indus and Ganges (or the Indo-Gangetic Plain); (*c*) the Peninsular Plateau. The Himalayas, over 20,000 feet high and with many higher peaks, stretch from north-west to south-east for 1,500 miles, forming the natural boundary of India on the north. The southern flank of the range is occupied by the hill states of Kashmir, Gharwal, Bhutan, and Sikkim, and by the kingdom of NEPAL (q.v.), the home of the Gurkhas. Above 5,000 feet the climate of the hills is healthy, and here are found hill stations such as Simla and Darjeeling; but below this is a region of low hills covered with damp and unhealthy monsoon forest. Between these and the plain is a strip of undulating country covered with tall grasses, and strewn with sand and boulders spread by the torrential mountain streams as they reach level ground. This region is called the *Terai* or, in Bengal, the *Duars*.

Far to the north-west the eastern edge of the Persian plateau (12,000 feet) continues the mountain barrier of the Himalayas southwards from the valley of the Indus to the Arabian Sea. This mountainous region is called Baluchistan. It is penetrated by the Khyber and Bolan passes, through which India has been invaded many times in the past. In the east the Naga and Lushai hills and the Khasi hills of Assam run between the Brahmaputra valley and the Bay of Bengal, forming the frontier with Burma.

THE INDUS AND GANGES PLAINS separate the Himalayas from Peninsular India and make up the vast lowland known as the Indo-Gangetic Plain, which is roughly 2,000 miles long and

A SOUTH INDIAN VILLAGE MARKET. *D. Spenser Hatch*

about 250 miles wide. It is covered to a depth of many thousands of feet with sediments washed down by rivers from the mountains. The western part of the plain is the Punjab, or Land of the Five Rivers—the five main tributaries of the INDUS (q.v.). They provide water for irrigation in a region of low rainfall, and make the Punjab one of the most productive areas of India. South of the Punjab is the desert of Sind (part of the great Thar desert), fertile only near the Indus valley, where there are irrigation works. The main town of this part of India, and the capital of Pakistan, is Karachi. A low watershed separates the Indus river system on the west from the GANGES (q.v.) on the east. The Ganges Plain, one of the most thickly populated and productive lowlands in the world, is covered with a close pattern of fields and villages, but is flat and monotonous, with only a few trees. Along the plain the river meanders slowly, carrying a great volume of silt and mud to the sea. In the hot season the soil is hard and dusty, and very little will grow; but in the wet season it becomes muddy and fertile, and crops grow quickly. In Bengal the Ganges spreads over the flat coastal plain in a huge delta, mingling with the sea in a waste of marshy islands called the 'Sundarbans'.

The plain is extended to the north-east by the valley of the Brahmaputra, which flows west

ON THE EDGE OF THE SIND DESERT

from the Himalayas, and then south to join the Bay of Bengal near the Ganges Delta. This part of the plain is subject to heavy floods, which often destroy the crops and cause terrific loss of life. Tigers are found in the coastal jungles, and malarial mosquitoes breed widely.

THE PENINSULAR PLATEAU, or the Deccan, is built up of ancient rocks. In the north-western part an area of basalt which has weathered into black soil is particularly suitable for growing cotton. It is drained westwards to the Arabian Sea by the Narbada River. The rest of the plateau is covered with hard, dusty, red soil which in general yields poor crops. On the west coast the plateau rises sharply like a flight of stairs from a narrow coastal plain, nowhere more than 50 miles wide, to form an escarpment 8,000 feet high. This highland is called the Western Ghats—an Indian word for 'steps'. From the summit of the Ghats the land slopes eastward to the Coromandel coast, and long rivers, such as the Kistna and the Godavari, drain the uplands and extend the eastern coastal plain seaward in sandy deltas. Near the southern tip of the peninsula there is a gap, the Palghat Gap, between the Nilgiri and Anaimalai hills, which is important because it makes an easy route from the west to the east coast. South of the Palghat Gap, the Cardamom hills extend to Cape Comorin, the southernmost tip of India.

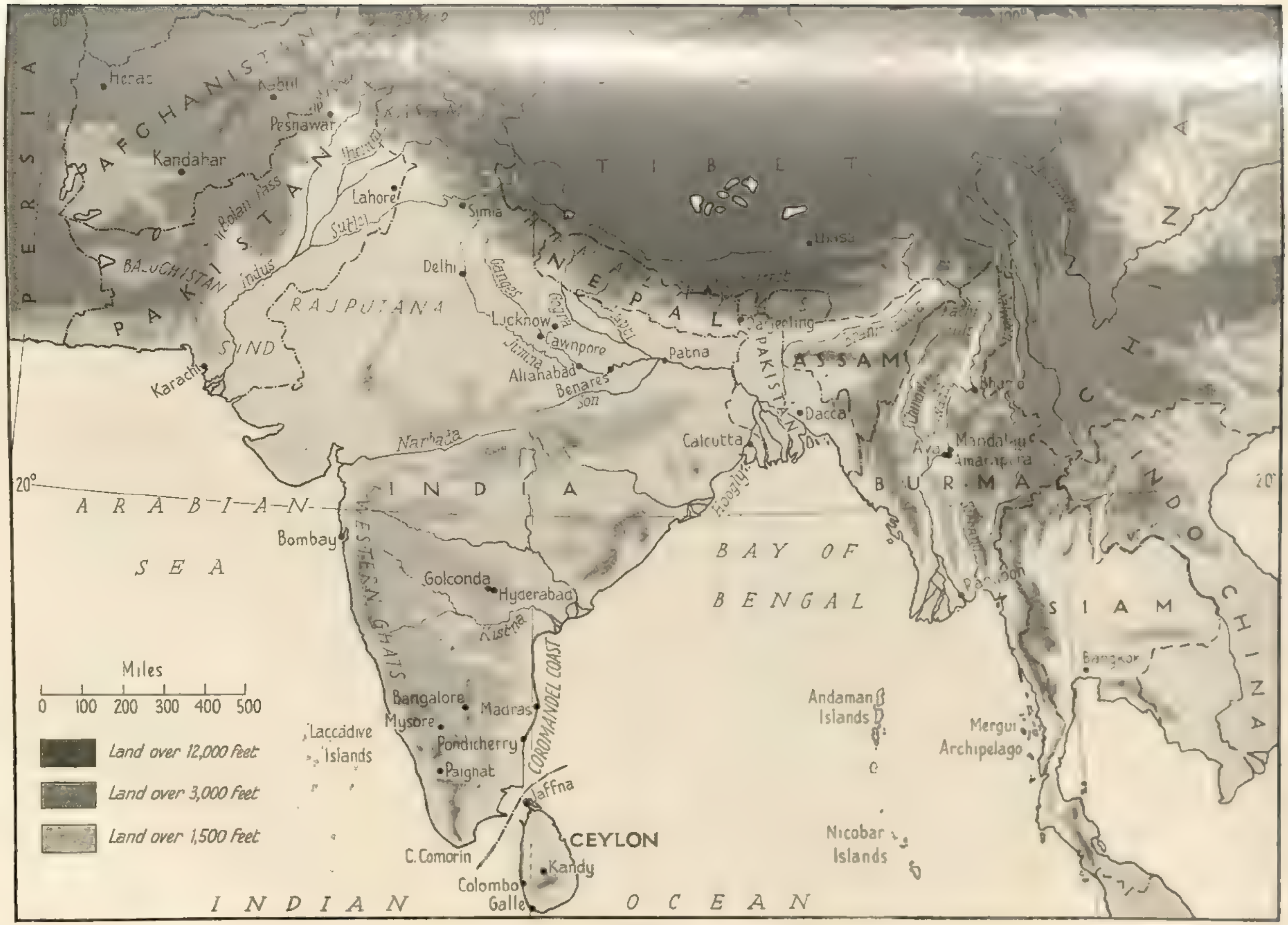
Forest still covers large areas of the plateau. This ranges from thick monsoon forest, and teak on the wet uplands, to dry thorn scrub in areas of low rainfall. Animals such as wild pig and deer live in the forests, snakes are plentiful, and crocodiles infest many of the rivers. Groves of coco-nut palms, peopled by chattering monkeys, are characteristic of the coastal areas.

CLIMATE. The Indian climate is one of extremes. Either severe drought or floods may ruin the agricultural crops. In the Punjab temperature varies from 120° F. to nearly freezing-point; while on the east coast calm days may be followed by violent cyclones. In general the cool-weather temperature in India corresponds to European summer temperature, while in the hot weather the temperature rises to a height unknown in Europe. The seasons are controlled by the north-east and south-west monsoons, and by the heat of the sun, which, in central India, is directly overhead in the summer. From October to February the north-east monsoon brings cool dry weather to India, except where winds, passing southwards over the Bay of Bengal, carry rain to the east coastal plain. Madras gets most of its rain in November; a little rain falls also in the Punjab in this season (*see* MONSOON).

From March to June is the hot weather, when a torrid sun bakes and parches the land. On the coasts there are occasional showers, but these make the air humid, so that the heat is perhaps even more difficult to bear than in the interior.

At the end of June the south-west monsoon brings rain, and a grateful drop in temperature. The Western Ghats, which face the rain-bearing winds, get up to 200 inches of rain; but the amount diminishes to 30 inches on the eastern part of the plateau. A branch of the monsoon blows northward up the Bay of Bengal, depositing heavy rain on the southern slopes of the Himalayas. The highest rainfall in the world is found here. Deflected by the mountain barrier, these winds are drawn westwards up the Ganges Plain to the heated interior, losing their moisture as they go. Rainfall drops from 59 inches at Calcutta to 18 inches in the Punjab. August brings an end to the rain, and as the clouds gradually clear away, temperature rises until the onset of the north-east winds cools down the land again.

PRODUCTS OF INDIA. Nearly 90 % of the population of India live by farming, and are therefore dependent on the monsoons. Failure


PERSIA
AFGHANISTAN
Herat
Kabul
Peshawar
Kandahar
Bolan Pass
Lahore
Simla
Sutlej
Indus
BALUCHISTAN
PAKISTAN
SIND
Karachi
RAJPUTANA
Delhi
Ganges
Lucknow
Cawnpore
Jumna
Allahabad
Benares
Son
Patna
TIBET
NEPAL
Darjeeling
PAKISTAN
ASSAM
Dacca
Calcutta
Hooghly
Narbada
INDIA
ARABIAN SEA
Bombay
WESTERN GHATS
Golconda
Hyderabad
Kistna
COROMANDEL COAST
Bangalore
Mysore
Madras
Pondicherry
Palghat
Laccadive Islands
Jaffna
CEYLON
Kandy
Colombo
Galle
C. Comorin
INDIAN OCEAN
BAY OF BENGAL
Andaman Islands
Nicobar Islands
BURMA
Bhamo
Mandalay
Ava
Amarapura
SIAM
Mergui Archipelago
CHINA
INDO CHINA
20°
60°
80°
100°
Miles
0 100 200 300 400 500
Land over 12,000 Feet
Land over 3,000 Feet
Land over 1,500 Feet
INDIA

of rain causes the famines which devastate India from time to time. In most parts of the country two crops are harvested each year. Rice, cotton, jute, and sugar-cane are sown in June and gathered after the rains. They are found in the areas of highest monsoon rainfall, or where supplementary irrigation is available from rivers swelled by rain from the Himalayas. Only the black soil of the Deccan grows cotton without irrigation: it is quite necessary on the poor soils covering the rest of the plateau. Rain-water is stored in wells and stone reservoirs, called 'tanks', and is then raised to the surface by primitive machinery driven by bullocks or by hand. It is in this part of India that famines are most severe. The second crop is sown at the end of the rains, when the soil is still soft, and is harvested in February or March. The chief crops are wheat, barley, millet, and oil-seeds.

Rice is the chief food crop in the lower Ganges valley and on the coastal plains, while the Punjab and the Upper Ganges valley are the largest wheat-growing areas. Other agricultural products of India are jute, cotton, tea and coffee, rubber, tobacco, and coco-nuts. More jute is grown in east Bengal than anywhere else in the world; and it is manufactured in CALCUTTA (q.v.). Tea grows in the hills of Assam, at Darjeeling, and in the Nilgiri hills in the south, where there is also a little coffee. Rubber, tobacco, and coco-nuts are found on the low-lying plains.

Industry is as yet unimportant in India, and is chiefly concerned with the processing of agricultural products, such as tea, cotton, and jute. Mineral resources have not yet been fully developed; but there is a large coal-field and steel-producing centre 190 miles west of Calcutta, with Jamshedpur as its chief town. Gold is mined at Kolar in Mysore. There has been some development of hydro-electric power—especially in the Western Ghats behind BOMBAY (q.v.).

In addition to the great ports, Calcutta, Bombay, Madras, and Karachi (the capital of Pakistan), there are many towns with a population of over 100,000 people in India. The largest of these are Hyderabad, DELHI (q.v.), which is the capital of the Republic of India, Ahmadabad, Bangalore, and Cawnpore.

See also PAKISTAN.
See also Vol. I: INDIAN PEOPLES.

INDIANA, *see* UNITED STATES OF [illegible]RICA.

INDIAN OCEAN ISLANDS. T[illegible] are the Spice Islands, sought after by the t[illegible]rs of the 15th and 16th centuries, and th[illegible]bject of many wonderful travellers' tales. T[illegible]ange in size from huge islands, like Madag[illegible]r in the west and some of the East Indies, t[illegible]y coral atolls (*see* CORAL ISLANDS). The [illegible] islands, MADAGASCAR, EAST INDIES, and C[illegible]ON, are described in separate articles.

Mauritius and Réunion, the most i[illegible]rtant of the Mascerene group of islands, lie som[illegible]00 miles east of Madagascar, and are generall[illegible] thought of as African (*see* Map, p. 322). Both [illegible]ve hot, damp climates, and periodically su[illegible]r great damage from tropical cyclones. M[illegible]uritius, first discovered by the Dutch and na[illegible]d after Maurice, Prince of Orange, is now [illegible] British Crown Colony. Coral reefs fringe its [illegible] coasts. Inland, hills, mainly of volcanic ro[illegible]ise to over 2,500 feet, and many are cov[illegible]l with forests of ebony, ironwood, and [illegible]mboo. Among the hills are fertile plains, whe[illegible]ops of sugar-cane, spices, vanilla, and rice a[illegible]rown. The island is well watered, and there [illegible] many lakes, often in old volcanic craters, a[illegible]rivers, which descend from the hills in fine w[illegible]rfalls. Port Louis, the capital, has a popu[illegible]ion of about 55,000. As Mauritius has an are[illegible]f only 720 square miles, and it has altogeth[illegible] about 475,000 people, it is densely populated[illegible]

Réunion (or Bourbon) is French. In[illegible]a it is nearly twice the size of Mauritius, but it is more mountainous, and has a much smaller population—only about 262,000. A chain of high volcanic peaks divides the east coast from the west. The highest peak, Pitou des Neiges, over 10,000 feet high, often has a cap of snow for several days at a time. The mountain slopes are thickly forested, and on the lower ground crops such as sugar-cane and spices are grown. St. Denis is the capital.

The Seychelles Archipelago, about 1,000 miles north of Mauritius, is a British colony consisting of about 100 islets and 6 islands, of which Mahé, some 50 square miles, is by far the largest. The islands are of granite and volcanic rocks, surrounded by broad coral reefs. COPRA (q.v. Vol. VII) from the coco-nut palm, vanilla, oils of cinnamon and clove, and tortoise-shell are exported. The islands produce a great many tortoises, including a huge land tortoise.

MAHÉ, SEYCHELLES. *Royal Mail Lines*

They also grow a very tall palm, the coco de mer palm, with an enormous double coco-nut which takes 10 years to ripen. These nuts were found by sailors in early times floating in the Indian Ocean, and they were the source of many [illegible] tales. Victoria is the chief town. The islands are inhabited by about 36,000 people of [illegible] origin.

The British Protectorate of Socotra lies about [illegible] miles off the north-east tip of Somaliland in the north-west India Ocean. It is mountainous, and its 12,000 inhabitants, mainly Arabs, are occupied in rearing cattle, sheep, and goats, and growing dates.

The Laccadive Islands lie off the west coast of the peninsula of India, and to the south of them are the Maldive Islands. All are low coral islands, rarely more than 20 feet above the sea, and growing mainly coco-nut palms. The Laccadive Islands have approximately 14,000 people, and the 14 atolls of the Maldives about 83,000. Fishing is an important occupation. South of the Maldives lies the Chagos Archipelago, coral islands whose chief industry is coco-nut oil.

The Andaman and Nicobar Islands, about 200 islands in all, are a continuation of the Arakan hills of Burma southwards into the Bay of Bengal, and are, consequently, made of folded rocks. Both groups are bordered by coral reefs, and there are volcanoes in the Andamans rising to 2,400 feet above the sea. Coco-nuts grow on all the islands, and a small amount of copra and coco-nut fibre is exported, principally from Port Blair, the chief harbour. The native pigmy inhabitants are interesting because of their exceedingly primitive way of life (*see* ANDAMAN ISLANDERS, Vol. I); but they are gradually dying out.

The Cocos (or Keeling) Islands, which have been since 1857 under British protection, are a group of 23 coral islands and atolls about 600 miles west of Java. Charles DARWIN (q.v. Vol. V) visited these islands, and it was on the observations made there that he based his theory of the origin of coral reefs. The population are occupied for the most part in the copra and coco-nut oil industry.

Christmas Island, a British colony south of Java, is of volcanic rock overlaid with limestone. (This is one of two Christmas Islands—the other being an atoll in the Pacific Ocean.) The working of very rich deposits of phosphate of lime occupies most of the population of about 1,500.

THE BAY OF ALONG, NEAR HAIPHONG, INDO-CHINA
Margot Lubinski

INDO-CHINA. Two thousand miles east of the peninsula of India, on the other side of the Bay of Bengal, another great peninsula juts out southward from the Asiatic continent (*see* Map, p. 87). The eastern part of this is Indo-China. Once part of the French Empire, it consists of four federated states—the Viet-nam Republic (Tonking and Annam), Laos, Cambodia, and Cochin-China.

In shape the country is roughly like a dumb-bell standing on end, about 1,000 miles long from north to south, with a waist about 100 miles across from east to west, and two bulges north and south, each about 500 miles across. The total area is nearly 300,000 square miles or over three times that of Great Britain. Indo-China is bounded on the north by China and on the west by Siam, with a short stretch of the Burmese frontier between. To the east and south is the South China Sea, which sweeps down in an S-shaped coast-line more than 1,500 miles long, the upper half forming a wide bay called the Gulf of Tonking.

The country's prosperity chiefly depends on the rich lowlands of the north and south. The narrow, central part is taken up by a range of mountains, the Chaîne Annamitique, which forms a barrier between the two main areas, so that the only way of going from north to south by land without crossing the mountains is to skirt the coast the whole way round. This fact has made it difficult for a good system of communications to be built up.

In the northern area the lowlands lie on the east along the shore of the Gulf of Tonking, the west consisting mainly of mountains and high plateaux. The state of Laos in the west has large areas of dense forest and swamp in the valley bottoms, where live a great variety of tropical jungle animals, such as rhinoceros, elephants, leopards, and thousands of monkeys. The lowlands in the southern area are larger than those of the north; the only mountains here are the tail-end of the Chaîne Annamitique in the east and a smaller mountainous area in the west.

Each of the main areas, north and south, possesses a great river in addition to many minor ones—in the north the main river is the Fleuve Rouge or Red River, so called because of the red silt which it carries, and in the south it is the Mekong. Both rise in the mountains of western China. The Fleuve Rouge flows into the Gulf of Tonking; the Mekong—a much longer river, 2,500 miles long—flows into the South China Sea at the southern tip of Indo-China. Both rivers have, in the course of many thousands of years, brought down and deposited at their mouths vast quantities of silt, thus building up the land farther and farther out to sea, and forming broad deltas. In both north and south these are now the richest part of the lowlands. The fertile soil of each is intersected and plentifully watered by the numerous streams into which the rivers divide before reaching the sea.

Lying, as it does, some hundreds of miles north of the Equator, in about the same latitudes as southern India, Indo-China's climate is classified as of 'tropical monsoon' type. It is a hot climate, with two main seasons. In winter, when it is cold in the great land areas of northern Asia, making the barometric pressure there high, air is driven south-westward from Asia across Indo-China. During this season, that of the north-east monsoon, there is hardly any rain in Indo-China, since the wind is blowing from across the land and is consequently dry. In summer the conditions are reversed, and the south-west monsoon blows, depositing as heavy

rain th[illegible]ter it has drawn up in passing over the oc[illegible] expanse farther south. In the low-lands [illegible]lo-China the atmosphere is always hot a[illegible]noist, by our standards, and the combi[illegible] of heat and moisture makes the climat[illegible]ing for Europeans. Malaria and other [illegible]al diseases are common. Only in the moun[illegible] of the north does a little snow occasi[illegible] fall.

Spe[illegible]lar features of Indo-China's climate are th[illegible]oons which often strike the east coast, havin[illegible]ginated in the China Seas. These terrib[illegible]rms are soon over; but they may do great[illegible]ge as they pass (*see* HURRICANE).

Ag[illegible]ure is the main occupation of the peopl[illegible]e being the principal crop. The rice-fields [illegible]ept covered with water while the crop is gro[illegible] and the fields are surrounded by low earth [illegible]ls to hold in the water. To raise enou[illegible]ater to the fields from the streams, the peasa[illegible]ften have to work for long hours at primi[illegible]vater-wheels. The rice crop provides most [illegible] people's food, and in addition much is ex[illegible]ed each year. The chief draught anim[illegible]re oxen and buffaloes, which are well suite[illegible] drawing ploughs through the deep mud [illegible]e rice-fields.

In[illegible]ina, and especially Tonking, has great mineral wealth, which the French have developed to a considerable extent. Most important is coal-mining, nearly all of which is in Tonking in the north-east. Most of the towns have grown up on the lower reaches of the two great rivers in the densely populated lowlands, and the roads and railways constructed by the French are mainly in the lowlands and round the coasts. The main ports are Haiphong in Tonking in the north, and the big port of Saigon in the south of Cochin-China. Hanoi is the capital—a city of 160,000 people, situated some way up the Red River from Haiphong.

See also Vol. I: INDO-CHINESE.

INDUS RIVER. This great river of western Pakistan rises in Tibet at a height of over 16,000 feet, and flows north-west for 600 miles, through Kashmir, following the trend of the HIMALAYAS (q.v.; *see* Map, p. 229). It is overshadowed by great mountains, 20,000 feet high, which keep out monsoon rain, making the valley of the upper Indus cold, arid, and desolate. Tributaries, many of them issuing from glaciers, come from the Karakoram mountains in the north, and the Zaskar and Ladakh ranges of the Himalayas in the south. Sometimes the Indus becomes dammed by boulders, or by ice, and when the

THE LLOYD BARRAGE ON THE INDUS RIVER

dam bursts a destructive flood sweeps downstream (the name Indus means 'flood'). The only two small towns in the upper Indus valley of any importance are Skardu and Leh, a station on the caravan route which crosses the Karakoram to Tibet and the Chinese province of Sinkiang.

Near Skardu the Indus cuts through the mountains in a tremendous gorge more than 10,000 feet deep, then turns southwards, and flows towards India. About 800 miles from its source it is joined from the west by its main tributary in this part of its course, the Kabul River, which drains the Hindu Kush mountains of Afghanistan. After this the Indus is navigable, and at Attock, where it is 2,000 feet above sea-level, it leaves the mountains and flows into the Punjab.

The name Punjab, meaning Five Rivers, refers to the Jhelum, Chenab, Ravi, Beas, and Sutlej, which are tributaries of the Indus. They rise in the Himalayas, and flow southwards to join the Indus as the fingers of an outstretched hand join the wrist. The Punjab is watered by irrigation from these rivers. Canals have been constructed to draw off flood-water, and to carry water from dams high up in the Himalayan foot-hills down to the dry plain. Electricity is also generated by water-power for Punjab towns such as Lahore.

After it has been joined by the Five Rivers in the south-west of the Punjab, the Indus flows south-west and then south through the flat desert plain of Sind. Its breadth varies from 2,000 yards to several miles in times of flood, and in places it is diverted by sand-banks into many channels. Below the town of Sukkur, in Sind, the Indus passes through a narrow gorge, over which a bridge carries the railway from India to Baluchistan. Near here, too, is the Lloyd Barrage, a great dam completed in 1932, which provides a head of water to irrigate $5\frac{1}{2}$ million acres of the lower Indus valley. This area was formerly desert, but now is intensely cultivated by peasant farmers.

The Indus reaches the Arabian Sea in a delta which, being liable to flooding with brackish water, is largely waste-land, supporting only wild birds. Goods for export, especially wheat and cotton, are brought in native boats down-river from the Punjab to the port of Karachi, which lies on the coast to the west of the delta. From its source to the sea the Indus is about 1,500 miles long.

See also Rivers; India.

ION (Ionization), *see* Atom.

IOWA, *see* United States of America.

IRAN, *see* Persia.

IRAQ. From Syria to the Persian Gulf there stretches a corridor of lowland drained by the great rivers Tigris and Euphrates (*see* Map, p. 17). Northwards the land rises to the hills of Kurdistan in Turkey, and on the west and south merges into the desert plateau of Syria and Arabia. This is the ancient country of Mesopotamia (meaning 'between rivers') and the modern kingdom of Iraq, a sovereign state only since 1932. For centuries a province of Turkey, it was freed from Turkish rule after the First World War and governed by Britain from 1920 to 1932 under a mandate from the League of Nations. Although politically a new country Iraq has been called 'the cradle of civilization'. Remains of the great ancient civilizations of the Sumerians, the Babylonians, and the Assyrians (qq.v. Vol. I) are scattered over the plain. The sites of the cities of Ur, Nineveh, and Babylon are marked by huge mounds, most of which have been excavated in recent years.

There are three main geographical regions. The most important is the narrow corridor of lowland, the silt-filled depression nourished by the Tigris and Euphrates. These rivers bring down silt from the mountains in their spring floods and spread it over the plain, making a strip of fertile soil in the barren desert. Baghdad (q.v.), with a population of 552,000, lies on the Tigris in a central position in the plain. Near the Persian Gulf the lowland becomes a vast marshy delta, subject to disastrous floods, and pitted by many lakes. Basra, the port of Iraq, is situated on the main channel through the delta. The channel is kept navigable for steamers by dredging.

The second region is the upland to the north-west. It contains the Jazira, a desert plateau separating the upper courses of the Tigris and the Euphrates, and it rises gradually into the hills of Kurdistan. In this region are the oil-fields of Iraq, the largest being at Kirkuk. Mosul, with a population of over 340,000, is the chief town.

The third region is the desert which borders the plain on the south and west. This barren waterless area is peopled by wandering tribes

THE GRAND CANAL, BASRA, IRAQ. *Paul Popper*

who move from oasis to oasis in search of pasture for their herds of goats and camels.

The climate of Iraq is one of extremes. In summer the heat during the day is intense, and a dry north-west wind (*shamal*) sometimes brings dust-storms. At dusk the temperature drops, and nights are cold. In winter the wind comes from the south-east (*sharqui*) and is accompanied by showers of rain. The temperature may fall to freezing-point. Along the coast humidity is high; and in summer the damp heat makes life almost unbearable.

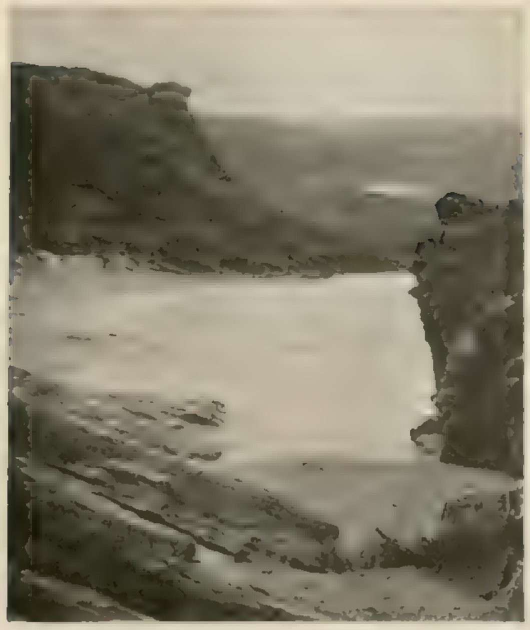
Wheat, barley, millet, and maize are the chief crops of the plain. In the marshy lands of the lower Tigris and Euphrates rice is grown. Near Baghdad and in irrigated areas in Kurdistan cotton is cultivated. The fertile foot-hills of Kurdistan produce vegetables, fruits, vines, and tobacco. The most important agricultural product, however, is the date—for Iraq produces four-fifths of the world's supply, chiefly from the 'date belt', a strip extending a mile or two on each bank of the Shatt al Arab, the main stream of the delta. Here there are millions of date-palms in plantations watered by numerous irrigation channels.

Raw cotton and a small amount of wool are also exported from Basra. Oil is piped directly from Kirkuk to Haifa on the Mediterranean, as well as being exported from Basra. Its oil resources have given Iraq an importance in the world out of proportion to its small size and population, of only about 4¾ to 5 millions—an importance strengthened by its position on the great natural land route connecting the Indian Ocean with the Mediterranean.

See also Vol. I: Iraqi.

IRELAND. Ireland, though a large island, is much smaller than Britain. The two islands were originally both part of the continent of Europe, so that men and animals could walk dry-footed from one to the other; but the sea washed in and divided first Ireland from Britain, and then Britain from the rest of the Continent. The Irish Sea is deep but quite narrow. On a fine day you can see the hills of Ireland from the coast of Scotland or Wales, and passenger boats make the crossing in a few hours.

The hills of Ireland rise sharply out of the sea and form an almost complete circle of high land round the coast, enclosing a flat central plain, so that the shape of the whole country is like an oval dish with a tall rim. It is about 302 miles long and 159 miles broad. In some places the coastal hills rise to mountains, such as the mountains of Mourne, the beauty of which is celebrated in Irish poetry. The Atlantic coasts



THE GALWAY COAST, EIRE
British Council

are wild and rugged, with treacherous rocks and cliffs hundreds of feet high. All along them is a succession of sea loughs and bays—some of them great harbours, like Lough Swilly in Donegal and Bantry Bay in Cork. Ireland has many rivers—the SHANNON (q.v.), for instance, the Boyne, and the Blackwater—and most of them wind for miles inland before they find a way through the barrier of hills to the sea. But above all, Ireland is the land of lakes. The picturesque lakes of Killarney are no doubt the best known; but there are hundreds of others, large and small, lying among wild and beautiful mountains. In most of the lakes and rivers there is excellent trout and salmon fishing.

Ireland is divided into four almost equal provinces—Ulster, Munster, Leinster, and Connaught—and into 32 counties. The 26 southern counties form a separate state called Eire, or the Republic of Ireland, which has been independent of Britain since 1937. In the north, however, the six counties of the province of Ulster preferred to stay as part of the United Kingdom when the others broke away in 1922.

If you ask an Irishman away from home what he misses most about Ireland, he will probably tell you 'the greenness'. And he may add—for the Irish are a homesick people—'When shall I see the real green grass again?' Irish poets put this in a different way when they cal[illegible] 'The Emerald Isle'. Is the grass real[illegible] in Ireland? The fact is that the prevai[illegible] blow in from the Atlantic Ocean and [illegible] air and soil warm and damp. And [illegible] these mild wet winds there are the ma[illegible] and inland waterways. Grass grows w[illegible] in such a climate. The Irishman does [illegible] wet weather. He calls a rainy morning [illegible] soft day'; or if it is really pouring, he [illegible] 'good growing weather'.

Ireland is an agricultural country, [illegible] cattle, sheep, horses (some of the best [illegible] the world), dairy products, and whisk[illegible] half of the 20,371,125 acres are fertil[illegible] them you find prosperous farmers [illegible] comfortable stone houses. But on the [illegible] especially in Connemara and in the D[illegible] Highlands, the farmers lead a hard life, [illegible] to scrape a living for their large famili[illegible] they cannot even afford a cart-horse-[illegible] see tiny donkeys pulling the carts alo[illegible] snail's pace. The poorer people depen[illegible] on potatoes for food, because the pot[illegible] grow almost anywhere and an acre's c[illegible]

IRELAND

THE SPERRIN MOUNTAINS, NORTHERN IRELAND. *G. M. Boumphrey*

fe[illegible] a family for a year. In some of the islands of [illegible]e west coast, such as the Aran Islands and t[illegible]sket Isles, life is even more primitive, and co[illegible]act with the mainland very slight.

[illegible]and has very little coal and iron; and so th[illegible]e are very few industries, except in the north, w[illegible] there are linen mills and the great ship-y[illegible]s of Belfast.

[illegible]ne-seventh of the whole of Ireland is covered by 'the bogs'. These are deep and ancient marshes. On the top they are damp and grassy; but underneath there are layers of dark rich soil called 'turf'. The country people use dried turf for fuel, cutting it out of the bog with special spades called 'slanes'. Although dried turf only gives off about half the warmth of coal (it takes half an hour to boil a kettle), it is, of course, much cheaper; and as it burns it gives off a sweet and peculiar fragrance.

Because there are so few industries and so few big towns, the soil of Ireland has been very little disturbed during the centuries, and so turf-cutters and other people digging in the bogs often turn up strange buried objects left there by their ancestors long ago. Gold ornaments have been found which may be 2,000 years old, and skeletons which look as though they must have belonged to giants. From these discoveries, archaeologists (who study such things scientifically) have been able to piece together, bit by bit, something of the ancient history of Ireland.

See also Belfast; Dublin; Giant's Causeway; Marsh and Moorland.

See also Vol. I: Irish.

IRON-STONE, *see* Metal Ores. *See also* Vol. VIII: Iron and Steel.

IRRAWADDY. In the little-explored mountains on the borders of Tibet, China, and Burma three great rivers—the Mekong, Salween, and Irrawaddy—rush side by side in great gorges several thousand feet deep. Nowhere else on the earth's surface, except, perhaps, the gorges of the Indus (q.v.) in north-west India, are there comparable gashes. The Irrawaddy is the smallest of the rivers; but nevertheless it is navigable by quite large steamers as far as Bhamo, 900 miles from the sea and only 30 from China. It is a great artery through Burma (q.v.) from north to south (*see* Map, p. 229).

The upper Irrawaddy is a torrential stream flowing through magnificently forested hills, often in gorges. Above Bhamo only launches can penetrate—and then only in the dry season, when the current is less fierce. From Mandalay

RAFT-MAKING ON THE IRRAWADDY. *R. Gorbold*

to the junction of its great tributary the Chindwin, the river swings westward in a great bend. This is the heart of Burma and here are the old capitals—Mandalay (q.v.), Ava, Amarapura, Pagan—built in low dry hilly country crowned with innumerable ancient pagodas. The ruins of the oldest capital, Pagan, are not far from the great steel railway bridge, the Ava Bridge—the only bridge across the Irrawaddy. Pagan was a great city 900 years ago, but now only a handful of villagers live amid scores or even hundreds of crumbling pagodas, from little wayside shrines to the splendid soaring mass of the Ananda, one of the most beautiful buildings in the world.

Below Pagan are oil-fields. At one point the oil-bearing rocks lie under the river, and the derricks of the wells rise straight out of the water. Finally, the Irrawaddy enters the great delta which its silt is building out to sea. Except for the swampy, crocodile-infested jungles and mangroves along the coast, the delta is mainly a sea of rice, with villages like islands on tiny rises, or strung out along the raised dykes of the bigger streams—the only dry areas in the rains, and in the dry season the only places with water to drink.

The life of Burma has always been bound up with the Irrawaddy, and one of the best ways of seeing the country is by Irrawaddy Flotilla steamer. These take nearly a week to reach Mandalay from Rangoon; and it is almost like a leisurely sea-voyage, though never out of sight of land. At all the ports there are gaily-clad groups of people bargaining in the riverside markets or bathing in the stream. Nowadays there are very few of the old big, Burmese boats, with high, wonderfully carved poops, gilded and brightly painted; but after the harvest, on all the countless creeks of the delta there is a constant procession of steam launches, paddy gigs, and sampans, carrying rice to the mills of Rangoon and so to the markets of the world.

See also Burma; Rivers.

ISLE OF MAN. This island lies in the Irish Sea, about 56 miles from the English coast. It is ruled by a Lieutenant-Governor, appointed by the Crown; but it has its own parliament, the *Tynwald*, its own laws and taxes, and its own

language, a form of Celtic, though this has nearly died out. The people of the island, called the Manx, are very proud of their ancient liberties and laws (*see* GAELIC LANGUAGES, Vol. IV).

The Isle of Man was overrun successively by Celts, Norsemen, Scots, and English. The Celts introduced Christianity to the Island in the 5th century—according to legend, through St. Patrick of Ireland. From the Norsemen has come the ancient Tynwald ceremony—the custom of calling the people together at the *Thing-Vollr* or 'Parliament Field' in the centre of the island to receive their laws. This ceremony was preserved under the Scots and English, and to-day no Act is valid until it has been proclaimed from Tynwald Hill in the Manx and English tongues.

The Isle of Man is about 30 miles long and 12 miles wide. A double range of hills, rising in Snaefell to over 2,000 feet, stretches from near Ramsey in the north to the tiny rocky Calf islet at the extreme south. Charming narrow winding glens studded with trees, and moorlands covered with heather contrast with the bare hill-tops. In the south-west, where the hills descend steeply to the sea, the scenery is most striking. The coast is extremely precipitous and rocky—indeed part of the Spanish Armada came to destruction on these rocks at a point now called Spaniards' Head.

Of the population of about 50,000, half live in Douglas, the capital, or in Ramsey. The picturesque 'towns' of Castletown, Port St. Mary, Port Erin, and Peel on the south and west coasts are really little larger than big English villages. At Castletown is King William's College, a well-known boys' public school.

As the island is encircled by the Gulf Stream, it has a very mild climate, with winters so much warmer than in England that fuchsias, hydrangeas, and other exotic shrubs grow luxuriantly in the open air. Almost all the people are engaged in agriculture, a little fishing, and the tourist industry. Thousands of visitors come to the island every year, and steamers run all the year round between the Isle of Man and Greenock, Dublin Liverpool, and Belfast.

See also ENGLAND.

ISOBAR, *see* WEATHER FORECASTING.

ISOTOPE, *see* ATOM.

ISRAEL, *see* PALESTINE.

ISTANBUL (CONSTANTINOPLE). Although Ankara is now the capital of Turkey, Istanbul,

CASTLETOWN, ISLE OF MAN. *Isle of Man Publicity Board*

THE GOLDEN HORN, ISTANBUL. *Paul Popper*

or Constantinople as it used to be called, is by far the most important city. It stands at a meeting-place of Asia and Europe, on both sides of the southern end of the Bosporus, the narrow channel which links the Black Sea to the Sea of Marmara. There are three main parts to the city. On the west and European side of the Bosporus are Stamboul and Galata-Pera, separated by the Golden Horn, an arm of the Bosporus, 4 miles long and half a mile wide. On the east and Asiatic side of the Bosporus lies Scutari (Uskudar), a Moslem city built on the lower slopes of a hill which rises abruptly to 850 feet above the sea.

Stamboul is the oldest quarter of the city. When CONSTANTINE THE GREAT (q.v. Vol. V) made himself undisputed ruler of the Roman world in A.D. 323, he decided to found his new capital at the ancient Greek city of Byzantium. The new city was called Constantinople (or city of Constantine), and it was built on seven rather low hills lying between the Golden Horn and the Sea of Marmara. The remains of the ancient ramparts of Byzantium still mark the western edge of Stamboul. Constantinople was added to by succeeding rulers of the BYZANTINE EMPIRE (q.v. Vol. I). The great cathedral of St. Sophia was built by the Emperor JUSTINIAN (q.v. Vol. V) in A.D. 532; but when Constantinople fell to the Ottoman Turks in 1453, the cathedral was converted to a mosque. Although restored and added to at different times, it retains most of its original form. It is now used as a museum, as is also another famous old building, the Seraglio, the palace of the Turkish Sultans for over 400 years. The present Turkish city of Stamboul has many narrow winding streets, picturesque in their mixture of red-tiled roofs, domes, and minarets. There is a large bazaar quarter, crowded, and often squalid. Recently some of the more neglected parts of the city have been cleared and modernized.

Galata-Pera is the banking, shipping, and European shopping quarter of Istanbul. Its main streets with their warehouses, banks, offices, hotels, and consulates are clean and attractive. The smaller streets are often narrow and dark, while some are but narrow stone stairways.

Istanbul contains about 1,000,000 people—of many races and occupations. It is chiefly a great trading port, handling principally wool, silk, hides, mohair, timber, and wheat. It has, on the whole, a healthy climate, though it is liable to sudden sharp changes in temperature in the winter months from November to March.

See also TURKEY.

ITAL' This boot-shaped peninsula, jutting south... l from Europe into the Mediterranean Sea ... Iap, p. 160), is such a mountainous cou... ...it hardly any part of it is out of sight of m... ...ns. It is roughly four-fifths of the area of th... ...sh Isles, and has a population of about fort... millions.

I... ...orth it is cut off from the rest of Europe by t... ...s (q.v.) which curve in a high barrier, sepa... ...g Italy from France, Switzerland, Aust... ...nd Yugoslavia. The great lowland of Ital... North Italian Plain, is at the foot of the ... Along its northern edge Alpine valleys ope... the plain, and in these valleys lie the thre... ...at lakes—Maggiore, with undulating, culti... ...d shores, Como, with hills rising steeply all ... ...l, and Garda, so sheltered that there are ter... of lemons on the hill-slopes of its western sho... The North Italian Plain, roughly triang... in shape, stretches about 250 miles from its ... ...rn corner to the delta of the River Po and ... lagoons of Venice in the east. The Po, the ... ...est river in Italy, crosses the plain from we... east. It used to be bordered by marshy lan... ...ut most of it has now been drained by ca... ...nd ditches, and the river and its main tri... ...ies have been embanked. Much of the pl... ...cks a natural water-supply and has to be wa... ...l by irrigation ditches. Some of this irrigat... ...nd is used for rice-fields. On this plain, the great agricultural region of Italy, are grown wheat, maize, rye, and rice, and vines, mulberry-trees, flax, hemp, and sugar-beet. In early June much of the country is a sea of yellow waving wheat and dark-green maize, above which rise the mulberry-trees, often planted along the edges of fields. Vines are trained on poles and trees, and from a distance look like lines of girls dancing hand in hand. Cattle are kept, but are seldom seen in the fields, as they are stall fed. Their milk is made into butter or cheese, such as parmesan and gorgonzola.

At the south-east corner of the plain is the tiny republic of San Marino, united to Italy by treaty, but electing its own legislative council. It claims to be the oldest state in Europe. It has an area of 38 square miles, and a population of about 14,000. The city of San Marino is walled and situated on a hill. Most of the population are engaged in agriculture, but building stone is exported, as well as wine and cattle.

The Apennine Mountains curve in a spine from the western end of the Alps to the toe of the boot of Italy. They are a high barrier of varying width, broken by the gaps of Benevento and Catanzaro. The Central Apennines, north of the gap of Benevento, are the highest and widest part, rising to 9,560 feet above sea-level in the limestone peak of Gran Sasso. In the west they are lower, and enclose high plateaux and

LOMBARDY: VINES TRAINED ON MULBERRY TREES
Miss B. Burton Brown

THE COAST NEAR SALERNO, SOUTH-WEST ITALY
P. Hart

flat basin-like uplands which were formerly lakes.

West of the Central Apennines is a volcanic area with many extinct volcanoes and crater lakes, as well as VESUVIUS (q.v.), the only active volcano on the mainland of Europe. ROME (q.v.) lies on hills rising above the Roman Campagna, a plain which stretches south-east to the Pontine Marshes. Most of the Pontine Marshes has now been reclaimed by a complicated network of drainage channels. East of the Apennines there is a narrow strip of coastal plain, which continues southward to the [illegible] plateaux of the spur and heel of the bo[illegible]

It is natural to think of Italy—a Mediterranean country—as having warm, d[illegible] summers, with almost cloudless blue skies and mild rainy winters. This is true only [illegible] part of peninsular Italy. Northern It[illegible] at all seasons, with hot summers and bitter cold winters. Snow falls on both the Alps [illegible] Apennines, and Turin, at the foot of [illegible] has a colder winter than Copenhagen [illegible]mark. In MILAN (q.v.) houses ha[illegible] windows to keep out the bitter winds and damp fogs of winter, and double shutters to keep out the scorching suns of summer.

There are still large areas of forest on [illegible] and the Apennines, though much has been cut down. In places where the hills have been drastically deforested, serious damage i[illegible] by rains washing down great quantities of soil (*see* SOIL EROSION). Many hill-sides have been terraced by unmortared walls built of large stones, and the peasants have carried up earth to make fields, in which they grow vines, [illegible]rus fruits, and olives, with vegetables and co[illegible] between the trees. In spite of the dang[illegible] eruptions, the peasants cultivate the rich volcanic soil on the lower slopes of Vesuvius, where the best early fruit and vegetables are grow[illegible]

Italy has little mineral wealth; but the quick-flowing rivers of the Alps have been harnessed to supply electricity for the great industrial districts of Turin and Milan, and for the railways which have been electrified.

Despite her long coast-line, Italy has few good natural harbours. On the east coast, however, good harbours have been constructed at VENICE (q.v.), Bari, and Brindisi, and on the west coast, GENOA and NAPLES (qq.v.) are two of the finest ports in the Mediterranean.

See also SICILY.
See also Vol. I: ITALIANS.

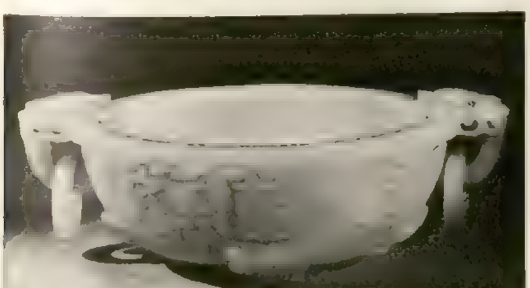
IVORY COAST, *see* GUINEA LANDS.

J

JACINTH, *see* ZIRCON.

JADE. There are two kinds of jade. Chinese jade, known to geologists as 'jadeite', is a silicate of sodium and aluminium. It has slightly greasy lustre and is a very tough fibrous substance. New Zealand jade is nephrite, a silicate of magnesium, calcium, and iron. It, too, is fibrous, but has a glistening appearance and is brittle. In its pure form jade is white, and where it is found in other colours this is because of the presence of metals, especially chromium. The most prized form of jadeite is a translucent, uniform 'peacock's tail' green, though white jade has always been especially valued by the Chinese. Otherwise good pieces are often marred by slight variation in colour or by white patches. Lighter greens, sage green, and whitish-greens are also in demand; but violet, orange, and pale-blue jade are not of great value.

The Chinese possess the best pieces, because, though Burma supplies almost all of it, China controls jadeite. A market is held once a year at Canton, at which bidding is done in secret by merchants clasping the hand of the auctioneer in such a way as to tell him their offer. In Chinese, the same word means either jade or precious stone though it is said that each shade has also its own particular name. Jade is associated with many legends and superstitions of China, and the Chinese have used the material for some of their most beautiful carving—exquisite animal and figure carving, ceremonial dishes, and objects for ordinary use, such as bowls and ink-wells.



JADE BOWL, CH'ING DYNASTY (1644–1712)
By Gracious Permission of H.M. the King

Nephrite is found in much larger quantities than jadeite and in several countries. The Maoris of New Zealand used it for implements, much as flint was once used in Britain. Supplies from eastern Turkestan are sent to China for carving. Other supplies come from South America, New Guinea, and British Columbia. Indian jade, so-called, or 'aventurine', is a form of quartz, and comes chiefly from India and China. It is usually dark green in colour, though lighter greens, yellows, and reddish-browns are also found. It contains dark specks of mica and haematite (iron peroxide) which glitter in certain lights.

See also MINERALS.

JAMAICA, *see* WEST INDIES.

JAPAN. The four main islands of Japan—Hokkaido, Honshu, Shikoku, and Kyushu—curve southwards and westwards in an arc which almost cuts off the sea of Japan from the Pacific Ocean. A narrow strait separates Hokkaido in the north from Karafuto, the southern spur of the long narrow island of Sakhalin, now part of the U.S.S.R. From off the east of Hokkaido, the Russian Kurile Islands make a line of stepping-stones to the tip of the peninsula of Kamchatka in the U.S.S.R., while from off southern Kyushu the Ryukyu Islands curve south-westwards to FORMOSA (q.v.). Honshu is much the largest of the islands, and is usually referred to as the Mainland. All round the main islands, and especially in the beautiful Inland Sea between Honshu and Shikoku, there are innumerable islands and islets. In all, Japan is about twice the size of Great Britain. Its population, which has increased vastly in recent years, is now about eighty-seven millions.

Most of Japan is mountainous: it has over twenty mountains which rise to heights above 8,000 feet, and there are some fifty active or sleeping volcanoes. The perfectly shaped cone of the volcano FUJIYAMA (q.v.) rises to 12,365

A HILL-SIDE TEA GARDEN IN JAPAN WITH RICE-FIELDS IN THE VALLEY BELOW
Paul Popper

feet. This sacred mountain of the Japanese is snow-capped in winter, and round its base lie beautiful lakes and hot springs (*see* GEYSERS). The upper slopes of the mountains are forested with oak, beech, pine, cedar, chestnut, maple, and bamboo, from which comes the raw material for many industries.

Japan used to be almost entirely an agricultural country—but the 20th century has seen immense industrial development. Abundant streams flow off the mountains, allowing the fields of the terraced lower slopes and of the few plains to be irrigated for the growing of rice, the chief crop. Fields are small, and the methods of cultivation in use are generally simple and primitive. Silk is an important product, and tea, grown on the hill-slopes, is cultivated for export as well as for home consumption. Soya-beans and many kinds of fruits are cultivated—indeed, the blossoming of the plum and cherry trees makes the Japanese spring a most lovely time of year. Fishing, especially for herring, is an important industry, for fish are plentiful in the many bays around the islands, as well as in the seas beyond.

Japan suffers from both typhoons (*see* HURRICANES) and EARTHQUAKES (q.v.). The latter are said to average about four a day—though, of course, most are very slight. In consequence, lightly constructed houses are built, so that they

can fall without causing great damage, and be quickly replaced. The modern buildings in the large towns are built of concrete, reinforced to withstand shocks.

Wages, and consequently the standard of living, are low in Japan; so that, before the

JAPAN

Second World War, large quantities of very low-priced goods—silks, cotton, pottery, lacquer work, rugs, matches, glassware, and toys—were sent all over the world. The great development of industry in the 20th century led to the growth of large towns.

TOKYO (q.v.), the capital, is situated on the plain of Tokyo in western Honshu. A few miles away is YOKOHAMA (q.v.), its seaport, and a great international shipping centre. The largest city in Japan is Osaka, also in Honshu, which has grown up recently as a port and an industrial centre. Nagasaki, in Kyushu, and Sapporo in Hokkaido are other important industrial cities.

See also Vol. I: JAPANESE.

JAVA, *see* EAST INDIES.

JERUSALEM. The name probably means 'the abode of peace', and it is strange and sad that this ancient city has had so little peace in its long history. It is first heard of as Salem, the town of Melchizedek, who is thought to have flourished over 4,000 years ago. About 3,000 years ago it was mentioned as Urusalim. In 1045 B.C. King David of the Hebrews captured it from the Jebusites. The Babylonians, under Nebuchadnezzar, took it in 586 B.C. Alexander the Great probably visited it in 333 B.C.; and in A.D. 70 it was utterly razed to the ground by the Romans under Titus. In 637 the Arab conquerors, under Omar, occupied it. From 1099 to 1187 the Crusaders maintained the Latin Kingdom there. In 1517 Sultan Selim captured it for the Turks, who held it until it was liberated by the British under General Allenby, in 1917.

The 'Old City' stands on a plateau, situated some 2,500 feet above sea-level, cut by two great valleys, the Valley of the Kedron and the Valley of Hinnom, which meet in a sharp angle. Within this angle are five of the seven hills over which the city is spread, Acra in the north-west, Bezetha in the north-east, Zion in the south-west, Moriah and Ophel in the south-east. The other two lie beyond the valleys—Mount Scopus to the north, and the Mount of Olives to the east.

The ancient walls contain many stones from the very earliest Jebusite foundations, and stand as they were rebuilt by Sultan Suleiman the Magnificent in A.D. 1542. The limestone of which these walls and Jerusalem itself are built has a reddish-brown streak, and weathers to a rich yellow. In the light of the setting sun this tawny-coloured stone comes alive with a radiant, golden light, justifying the city's title of 'Jerusalem the Golden'. The spacious thoroughfares of modern Jerusalem lie outside the walls of the old city, with its narrow, crooked lanes, and stretch across the hills of Judaea. There are blocks of flats and fine up-to-date houses. The streets are among the most cosmopolitan in the world—Syrians, Lebanese, Armenians, Egyptians, Abyssinians, and Greeks mingle with Arabs and with Jews of all nations.

Scarcity of water has always been a problem in Jerusalem. The pool of Siloam and the Virgin's Fountain were the only natural sources in olden times. Accordingly, almost every house was built with a rock-hewn cistern in its foundations to store water, and public-spirited governors like Pontius Pilate built conduits and

DAVID STREET, JERUSALEM. *Matson Photo Service*

aqueducts to bring water from a distance—as from Solomon's Pool near Hebron. In recent years, when under British administration, supplies have been improved by a chain of pumping-stations from the coastal plain to the Holy City.

It is strange that Jerusalem has become a Holy City for three powerful world faiths, JUDAISM, CHRISTIANITY, and ISLAM (qq.v. Vol. I). It enshrines both the national and the religious aspirations of the Jews. To the Christian it is sacred because of its associations with Christ, and to the Moslem because it is the farthest west the Prophet travelled in his flight from Mecca.

See also PALESTINE.

JET. As an ornament, jet was more popular in our great-grandmothers' time than it is to-day. It is a black substance, light in weight, capable of being carved and highly polished. Like amber, jet has been used for adornment since very early times: in Great Britain finds have been made dating back to 2000 B.C.

Jet is a mineralized or fossilized product like COAL or ASPHALT (qq.v.)—and, in fact, some varieties closely resemble those forms of coal known as 'lignite', while others seem to have been derived from asphalt. If the former are examined under a microscope, the structure of coniferous trees can often still be seen, accompanied occasionally by fish scales. This suggests that the trees were submerged under the sea and then covered over by mud (now turned to shale), after which increasing pressure and heat continued for millions of years, slowly brought about the transformation into jet.

The best-known source of jet to-day, as probably in prehistoric times, is Whitby in Yorkshire. Whitby jet was well known to the Romans, and there was a flourishing industry there in the 19th century. The jet occurs in irregular masses in the cliffs and is either mined (as also in other places in Yorkshire), or picked up on the shore after having been dislodged by the sea. Other sources of supply are Spain, France, Germany, and parts of America.

See also ROCKS, Section 3 (*c*).

JOHANNESBURG. This city, the biggest in South Africa, is the centre of the world's greatest gold-producing area. It lies on a long ridge called the Witwatersrand (the Afrikaans for 'Ridge of White Waters'). Until 1886 this ridge, about 6,000 feet above sea-level, was bare veld, but then mining prospectors discovered outcrops of gold on it, and people from all over the world flocked there to try to make their fortunes. Very little of the gold was near the surface, however, and the gold-diggings were not like those of California, where a lucky strike might make a man rich in a day. The gold-bearing reef sloped downwards rather steeply, so that expensive machinery for boring and pumping was needed. This called for the formation of companies with large capital, and eventually led to the formation of the Chamber of Mines, a group of companies which to-day controls the whole GOLD-MINING industry (q.v. Vol. VII).

Johannesburg is a modern city with great modern buildings, including the University of the Witwatersrand, the biggest in the country, with a Medical and Engineering school. There are beautiful gardens and parks and also very ugly slums. Along the Reef (as the ridge is called) a number of towns have grown up, and the whole area is now the most thickly populated in the Union of South Africa. The most characteristic sight of the Rand is the mine dumps—huge heaps of waste material from

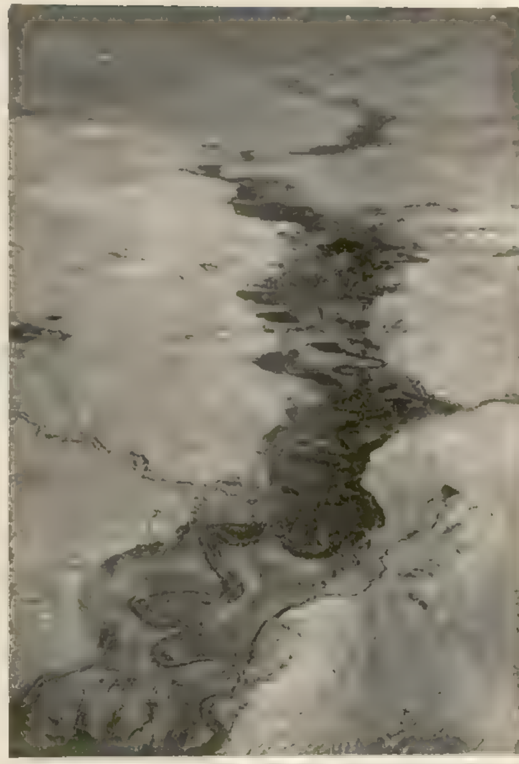
which the gold has been extracted. Johannesburg itself has 300,000 Europeans and an equal number of natives, but on the whole Reef the numbers are roughly 500,000 Europeans and 700,000 natives. This is about one-fifth of the European population of the whole country. Johannesburg itself is the biggest market for South Africa's agricultural products.

Large numbers of natives come from all over South Africa to work in the mines for spells of a year or more at a time. They live in compounds (native barracks) near the mines at which they work. All the actual mining work is done under the supervision of white men. When their contracts are over, the natives go back to their own territories.

The climate—dry winters and fairly well-distributed rain in summer—is healthy and pleasant. Most of the ill health among the miners results from the fine and very hard dust which fills the air and causes a lung disease called Miner's phthisis. The mines go down to a depth of 6,000 feet or more.

See also South Africa.

JORDAN. The name Jordan comes from the Hebrew word meaning 'to descend'—a very suitable name, for the River Jordan flows from Mount Hermon at the south of the Lebanon range, over 9,000 feet above sea-level, to the Dead Sea, some 1,300 feet below sea-level, descending in Palestine proper no less than 2,000 feet in 100 miles—a very steep drop for a river (*see* Map, p. 17). Though the Jordan first appears as a fully grown river from a cave at Banias, near the foot of Mount Hermon about a thousand feet above sea-level, its sources are at Hasbeya on the west side of Mount Hermon and are fed by the melting of the snow which lies there all year. From the cave it flows through thick copses and stately poplars to the basalt slopes near Dan on the frontier of Palestine, where it becomes lost in the papyrus swamps of the Waters of Merom. However, it gathers itself again into a channel, and forms a delta at the north end of the Sea of Galilee, which it leaves by a narrow, tortuous channel, from half a mile to one mile wide, carved in the bed of the valley. In its lower course from Jericho to the north end of the Dead Sea (q.v.) it descends more gradually and is yellow and muddy.



THE JORDAN VALLEY FROM THE AIR, LOOKING NORTH
B.O.A.C.

The Jordan valley was formed by a fault or fracture in the earth's surface at a time when the whole Middle East region was thrown above the sea by volcanic action. The valley bottom is very fertile, especially round Jericho, the 'City of Palms', where oranges and dates are grown; but it has never been cultivated as fully as it might have been, because of the torrid heat which prevails for most of the year. Only in January and February does the temperature become bearable. At this season those people of Jerusalem who can afford the luxury of a holiday are accustomed to escape the chilly weather of the mountains by retreating to Jericho and the country round.

See also Palestine.

JUPITER, *see* Planets, Section 7.

K

KAIETEUR WATERFALL (KAITUK). This magnificent fall, one of the greatest and most beautiful in the world, is made by the Potaro River, a tributary of the Essequibo River in British Guiana (*see* Map, p. 415). The journey to it is through such dense virgin forest that for long no white man ever saw Kaieteur.

A range of mountains forms its background. The Potaro River flows lazily along through the tropical forest, and does not begin to accelerate for the drop until it gets to within 30 to 40 yards of the semicircular lip of the fall. It then cascades into the rocky gorge below from a height of no less than 741 feet, five times the height of Niagara. The width of the river at the falls varies from about 80 to 200 yards according to the season. Unlike most falls, Kaieteur is practically noiseless at the top, and this adds to its impressiveness. Before the water reaches the river below, a great part of it has been turned into spray, which deadens the sound of the stream crashing on to the rocks. Perhaps the most spectacular feature of the falls is the wonderful changing colour of the water in the sunlight. As the falling water increases its pace, it changes from dark amber at the lip to golden amber, rich gold, light amber, cream, and finally to sparkling white. The spray as it falls takes more and more the shape of plumes, varying in colour according to their depth and the angle of the sun. Sometimes the plumes of spray give the strange impression that they are working upwards against the fall of the water. At times, when the wind sweeps up the gorge and blows the spray backwards and upwards, the fall is blotted out from view by a white curtain. Below the falls, the river flows through a magnificent gorge, with tremendous wooded cliffs on both sides.

Below the lip of the fall, the backwash of the water has hollowed out a large cave, in which flocks of swallows have made their ho… In the evening, the birds often circle in thous… above the falls. Suddenly, a hundred or …re will separate from the main flight, swoop b… nd the falling water, and disappear into … cave, always entering from the left bank. … they will shoot out again in small flocks from … e right bank, and soar aloft to rejoin their … rades. This flight is repeated many times b… they settle for the night.

A local legend is told of an Indian tr… living near Kaieteur. When a tribesman gre… oo old to be any longer of use, he was placed i… a bark canoe and launched on the Potaro, a… ve the falls, to take his last trip.

It is possible now to visit Kaieteur by plane—a distance of 140 miles by air from Geo…town. The journey by land takes several da…, but is very interesting and exciting. The firs… part is done by steamer up the Essequibo Rive… Then follows a 100-mile very rough lorr… drive through tropical forest. After that com… a trip up the Potaro in a small boat with an … board motor, through magnificent scenery, … with detours round impassable rapids. Final… on the fourth day, a 2 hours' climb through m… forest brings the traveller in sight of the fall…

See also GUIANAS.

KALAHARI DESERT, *see* SOUTH …RICA; DESERTS.

KANSAS, *see* UNITED STATES OF AME…

KARACHI, *see* PAKISTAN.

KAZAKHSKAYA (KAZAKHSTAN). This vast Soviet Socialist Republic stretches eastwards for about 2,000 miles from the Caspian Sea to the province of Sinkiang (*see* Map, p. 459). It is thinly populated, having altogether about six million people.

The great region of Kazakhskaya has many kinds of country. In the north there is a belt of steppe covered by rich black earth in which wheat and rye are cultivated extensively. Southwards this fertile steppe gets increasingly arid and poor until it becomes desert. Between the Aral Sea and the Caspian Sea is a clay desert rising in a low plateau above the plains round it. South of this, and again east of the Aral Sea there is sand desert, the northern stretches of the Kara Kum Desert (*see* TURKMENSKAYA). North and

KAIETEUR WATERFALL. *Royal Geographical Society*

A MOUNTAIN LAKE NEAR ALMA ATA, KAZAKHSKAYA *S.C.R.*

east of the sand desert a high plateau falls northward to the West Siberian steppes of the R.S.F.S.R., and southwards to the depression of Lake Balkhash. This plateau is stony and waterless, broken by salt marshes and moving sand-dunes. Along its south and south-west margins copper and coal are mined, and in the north is one of the biggest coal-producing areas of the U.S.S.R. South and east of Lake Balkhash the north-western slopes of the mountains of Kirgiskaya and Sinkiang mark the frontiers of Kazakhskaya.

In the extreme north-east corner of the republic there is an area of fertile depressions and valleys, with rich pasture, orchards, and fields of melons, tobacco, and sunflowers. This area is rich also in METAL ORES (q.v.)—gold, silver, lead, copper, zinc, and wolfram being mined. On the northern shores of the Caspian Sea, near Emba, lies one of the largest oil areas of the U.S.S.R. Though Kazakhskaya is crossed by several railways, there are still areas where camels provide the sole means of transport.

Alma Ata, the capital of the republic, is south of Lake Balkhash in one of the valleys leading to the mountains of Kirgiskaya. As in other valleys in these mountains, the fertile soils bordering the river are irrigated and planted with fruit-trees, or are cultivated with a wide variety of crops. The lower slopes of the hills are wooded.

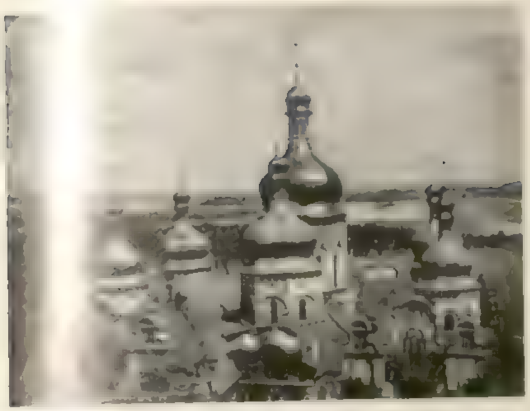
See also U.S.S.R.
See also Vol. I: SOVIET CENTRAL ASIAN PEOPLES.

KENYA, *see* EAST AFRICA.

KIEL CANAL, *see* Vol. IV: KIEL CANAL.

KIEV. This very old Russian city dates from the 5th century A.D., when it was founded by two Scandinavian knights, Dyr and Askold. These Norsemen, or Varangians as they were called, were enterprising traders who were trying to reach Constantinople by the River Dnieper. They settled in the rich lands of western Russia, and their leader, Rurik, became the prince of NOVGOROD (q.v.) in 862. His successor, Oleg, transferred his centre to Kiev twenty years later, and the country around Kiev became known as Russ. This was, indeed, the beginning of the Russian Empire.

Kiev, which is often called the 'Mother of Russian cities', grew in power as the result of vigorous trade—as well as by a certain amount of fighting, especially with Constantinople and the BYZANTINE EMPIRE (q.v. Vol. I). The various states of Russ had different rulers, but whoever ruled Kiev was considered the leader. In the 10th century the Princess Olga of Kiev became a Christian, and her grandson, Vladimir, chose the faith of the ORTHODOX EASTERN CHURCH (q.v. Vol. I) for himself and his people. Russia has been a stronghold of the Orthodox Church ever since. Vladimir's son built a great many magnificent churches in Kiev with the help of Greek architects and artists—indeed, in the 11th century there were said to be no less than 400 churches in the city. Perhaps Kiev's greatest period was under Vladimir's great-grandson, another Vladimir, who married the daughter of King Harold of England. In the 13th century the Mongols of central Asia began a series of invasions; and in 1240, Batu, the grandson of Jenghis Khan, and his Golden Horde captured Kiev and destroyed a great part of it (*see* TARTARS, Vol. I). In the 15th century Moscow became the leading city of Russia. Kiev is now the capital of the Soviet Socialist Republic of UKRAINE (q.v.), and the third largest city in Russia.



…ERS OF THE PRINCIPAL LAVRA CHURCH, KIEV
S.C.R.

… stands on a high bluff above the River Dn…er, just where the Dnieper leaves the for…-lands and enters the steppes. In early tim… the city was surrounded by walls and prote… against attack from the steppes by a great for…s. To-day it lies in wooded country, with orc…ds of pears, peaches, and apricots. The mo…rn city has wide streets, with avenues of po…rs and chestnuts, fine many-storeyed bu…ings, open squares, and beautiful gardens. Its …ctories produce machinery, textiles, chemica… and tobacco, and many of its citizens are en…ged in sugar-refining, flour-milling, and sh…building.

…he ancient buildings of Kiev, one of the mo…t famous is the great cathedral of St. So…hia, begun about A.D. 900 and restored at various times. Among its treasures are mosaics and 11th-century frescoes. There are two famous monasteries, the 12th-century Mikhailov Monastery and, high above the Dnieper, the Kiev Perchersk Monastery. Beneath this latter building, the Dnieper banks are honeycombed with caves and catacombs, and large numbers of pilgrims come every year to visit the remains of saints who are buried there. The churches and monasteries of the old Russian cities are very different from those of western Europe: they are Byzantine in style, very elaborate and full of colour, and the roofs are a mass of different-sized domes, often coloured green, gold, blue, red, or white (*see* BYZANTINE ART, Vol. XII).

See also U.S.S.R.

KIRGISKAYA (KIRGHIZIA). This Soviet Socialist Republic is in southern Asiatic U.S.S.R. (*see* Map, p. 459). It lies mostly within the Tien Shan Highlands, which sweep north-eastward from the Pamir Mountains in high, roughly parallel ranges 13,000–17,000 feet above sea-level (*see* ASIA). There are huge glaciers, vast snowfields, and deep lakes. The population is small—only about 1½ millions.

The mountains of Kirgiskaya provide pasture for about three million sheep—and the traditional dress of the herdsmen, with its turban-shaped cap and belted coat, is made of sheepskin. In the lower valleys, wheat and barley are grown and, where irrigation is practised, tobacco, cotton, and sugar-beet. Cattle are reared and one of the industries is meat-canning. Coal, mercury, antimony, tin, lead, and gold are worked. Some highland areas are covered with valuable forest. Besides its agricultural and mineral wealth, Kirgiskaya has an expanding tourist industry, attracted by the forested, snow-capped mountains and deep-blue lakes.

Frunze, the capital, is in the north.

See also U.S.S.R.
See also Vol. I: SOVIET CENTRAL ASIAN PEOPLES.

KOREA. This peninsula juts southward from Manchuria, west of the Sea of Japan (*see* Map, p. 87). It ceased to be a protectorate of China in 1895, and became independent under its own Emperor until, in 1910, it was absorbed into the Japanese Empire. After the Second World War

THE HIGHLANDS OF KOREA
Paul Popper

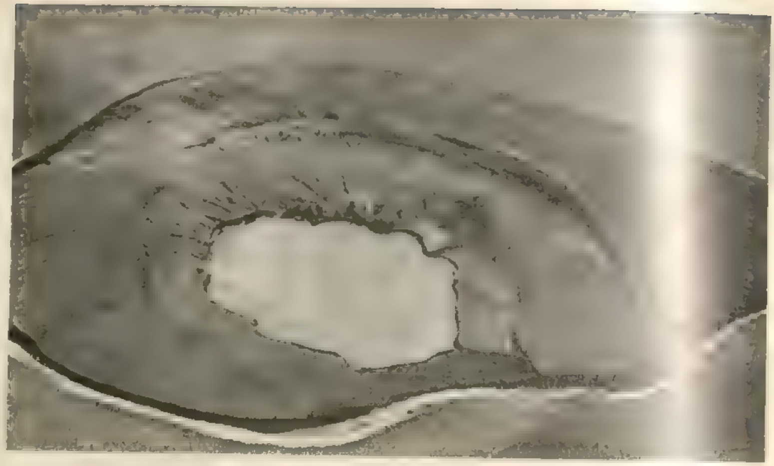
it came under American and Russian control, with a view to its eventual independence.

Korea is about 600 miles long and 130 miles wide, and had a population of some 28,500,000 in 1949. Almost three-quarters of the country is mountainous, including the northern part, and almost all the east coast. The slopes are too steep and the valleys too narrow to allow for much agriculture; but the abundance of tigers, leopards, boars, deer, otters, and sables makes the mountains excellent hunting-grounds. There are some fine trees; and flowering shrubs, such as rhododendrons and azaleas, flourish on the lower slopes. The highest peak, Mount Paikto-Shan, 8,000 feet high, is an extinct volcano, its crater now filled by a lake.

In the west and south are broad, fertile plains, and a coast-line of numerous bays and islands. Rice is the chief among many crops; silkworms are reared, and some cattle are kept. The considerable mineral wealth, especially of gold, had been little exploited until the Japanese took charge; for the Koreans had feared to disturb the dragons and evil spirits of the mountains. Fishing and whaling were also very much developed under the Japanese, though these had long been local industries.

Seoul, the capital and the largest town, has a population of over one million. It is situated on the western side of the peninsula, in the Han valley, and is surrounded by old city walls, 20 to 30 feet high, with eight huge gateways. Its port is Inchon.

KRAKATAU. The volcano of Krakatau is on an island in the Sunda Strait between Sumatra and Java in the East Indies (q.v.). Its career in the last sixty years has made it one of the most famous volcanoes in the world. In 1883, after 200 years of inactivity, it burst into violent eruptions, and on 26–7 August there occurred one of the greatest disasters in human history.



KRAKATAU FROM THE AIR

With a colossal explosion, which was heard as far away as west Australia and Ceylon, the greater part of the island of Krakatau was swallowed by the sea or blown into the sky, leaving only three small islands. Steam and ash were hurled up into the air to a height of about 12 miles, and ashes were showered over southern Sumatra and Singapore and as far as Batavia in Java. Dust rose up from the earth into the stratosphere, and caused wonderful sunsets all round the world for months after. The greatest destruction came from the vast waves up to 120 feet high, which resulted from the explosion. These flooded both shores of the Sunda Strait, rushing several miles inland and washing away scores of villages.

For forty-four years Krakatau was quiet, and the three islands became covered with vegetation. Then, about the end of 1917, a fourth island appeared above the waves, midway between the other three. This new island, Anak Krakatau or 'child of Krakatau', disappeared and reappeared three times. The fourth time it appeared was in 1930. Since then there have been many minor eruptions, and its size and height above the sea have varied considerably. The crater of the volcano contains a lake, and the rim of the crater is so little above the level of the sea that the sea is liable to spill into it. When this happens another eruption is likely to result.

See also Volcanoes.

L

LABRADOR, *see* NEWFOUNDLAND.

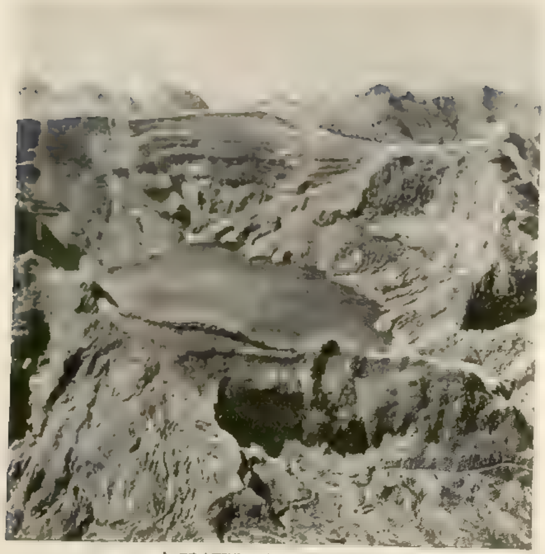
LAKES. A lake is formed when a hollow fills with water or when the natural drainage of an area is obstructed so that water piles up behind the barrier. Some lakes are of fresh and some of salt water.

FRESH-WATER LAKES. Some lakes, like the lakes in the rift-valleys of East Africa, are the result of earth movement: the crust of the earth has cracked, making a steep-sided chasm, or the earth has subsided, leaving a hollow. These have then filled with water. Many lakes were caused by glaciation (*see* GLACIATION). These are either long, narrow, very deep lakes (like the Scottish lochs and the lakes in Cumberland and the Alps), filling hollows excavated by glaciers; or they may be shallower lakes of various shapes and depths (such as are found in Canada, Finland, north-west U.S.S.R.), filling hollows that were once covered by ice-sheets. Deep circular lakes, such as are found in central France, parts of Germany, Italy, and Java, are occupying the craters of extinct volcanoes. In limestone country, water sometimes seeps into the weak parts of the rock, dissolving the limestone and forming caves with underground streams. As the rock continues to dissolve, the layers above may fall in, leaving a hollow which, fed by the underground stream, soon forms a lake (*see* CAVES).

Lakes are also made when the water of a stream is held up by a barrier. If a river is temporarily blocked by debris or by ice, a lake quickly forms, but disappears when the barrier is removed. Sometimes a fairly permanent lake appears in the disused channel of a meandering river, but a dry season may see its disappearance. Permanent lakes are caused when a landslip, or the lava from a VOLCANO, or the moraine of a GLACIER (qq.v.), blocks a valley and holds up a river. The water piles up until it can find a way through or over the barrier, and continue its way down the valley. An example of this last type is the Lake of Killarney in Ireland.

A LAKE FORMED BY GLACIATION: LOCH LUBNAIG, PERTHSHIRE

Leonard and Marjorie Gayton



A CRATER LAKE IN JAVA

SALT-WATER LAKES. These are of two types. Either they were originally part of the ocean and have then been cut off by earth movement, or they were at one time freshwater and have gradually become salt because of evaporation. The CASPIAN SEA (q.v.), the Aral Sea, and Lake Baikal in central Asia are believed to have once been parts of the sea. The GREAT SALT LAKE (q.v.) of Utah in the U.S.A. is a famous example of a lake become salt through evaporation. Geologists have proved that it was formerly fresh, because they have found freshwater fossils on the slopes of the surrounding hills. The DEAD SEA (q.v.) is another example.

Many lakes in tropical climates, especially shallow lakes with flat shores, vary greatly in depth from season to season. A striking example of this is Lake Chad in Africa, very large areas of which are nothing but swamp in summer. In cold and mountainous countries, such as the Alps, lake levels rise with the spring melting of snow and ice. Many lakes in the U.S.S.R., in Canada, and in the U.S.A. are fed by melting snow, and so increase greatly in volume in the spring.

Lakes are useful to man in many ways. They check the flow of rapid rivers—as, for example, the Rhine is checked at Lake Constance. They reduce or remove the risk of floods by spreading the flood-waters over their broad area. Some, such as the GREAT LAKES of North America (q.v.), the Victoria and Tanganyika Lakes of East Africa, and the Caspian Sea, are important route-ways. Many lakes serve as reservoirs for supplying water to towns, others for generating electricity. For this latter purpose a constant head of water is necessary; and as river power often varies from month to month, artificial lakes or reservoirs are often made by blocking up valleys with DAMS (q.v. Vol. VIII).

LAPIS LAZULI is a beautiful blue stone consisting of calcite with embedded grains of other minerals. It is used very often for inlay work and in jewellery. Formerly, when it was more abundant, it was used for bowls and huge ornaments. The deep-blue paint called ultramarine can only be made from finely powdered lapis lazuli, but now a cheaper substitute has been found. Large pieces of good lapis lazuli are very rare and very expensive; poor pieces are cheap. The best lapis lazuli is a deep rich blue, practically free from the yellow specks or whitish streaks which mottle most specimens (*see* Colour Plate opposite p. 288).

The oldest mines are reputed to be those of Afghanistan, which is known to have supplied ancient Egypt as early as 3000 B.C. To-day it still sends supplies for cutting to India, Russia, and Germany. Chile produces some also. It is thought that *lazuli* comes from an Arabic word meaning blue, while *lapis* is Latin for stone.

See also MINERALS.

LAPLAND, *see* Vol. I: LAPPS.

LATVIA. This is one of the Baltic Republics of the U.S.S.R.—a small country about the size of Ireland, with a population of only two millions (*see* Map, p. 459). From 1920 to 1940 it was an independent republic. It is a flat, predominantly agricultural country, growing flax, sugar-beet, cereals, and fodder for its dairy cattle. Woods of fir, pine, birch, and oak cover about a third of the country, and much of the timber for the important paper and match-making industries is floated down the West Dvina River. This river also provides power for generating electricity for Riga, the capital, the chief port, and by far the largest city. Riga was a town of the Hanseatic merchants (*see* HANSEATIC LEAGUE, Vol. VII), and the old city has fine examples of medieval architecture.

See also U.S.S.R.
See also Vol. I: LATVIANS.

LAVA, ... 'OLCANOES; ROCKS, Section 4.

LEAD O... *see* METAL ORES.

LEAP-Y... R, *see* CALENDAR.

LEBAN... *see* SYRIA AND LEBANON.

LENIN...**D.** In 1703 PETER THE GREAT of Russia ... Vol. V), having won from Sweden the co... of the Gulf of Finland and gained access ... Baltic Sea, built himself a new capital ... at the head of the gulf and called it St. Pete...rg. In 1914 the name was changed to Petr...l. Now it is Leningrad.

St. P...burg grew rapidly into a beautiful city, wi... palaces, broad squares, wide streets, spaciou...rks, museums, and theatres. The broad ... r Neva and the canals linking the Neva t... Volga, the Dnieper, the Don, and the No... Dvina were lined by magnificent emban...nts. Through its busy docks were shipped ... nber and furs from the north, flax and gr... rom the south, and coal, metal, and other ... materials imported. All this commerce ... cted much industry.

In 1917 the city was the centre of the Revolution; but later, as foreign trade was now of less importance than the building of the huge internal economy of the U.S.S.R. (q.v.), it lost its position as capital—Moscow (q.v.), a more convenient administrative centre, taking its place.

However, Leningrad has achieved a new importance as a centre for the training of technicians, for the building and testing of new types of machinery, and for production. It has vast engineering works and shipyards—indeed, it is said that there are very few types of machinery not manufactured in Leningrad. There are also chemical works, paper and timber mills, and textile factories.

This industrial activity depends on coal and iron from the Don Basin and from the Kola Peninsula in the north, brought by river transport and by the Baltic–White Sea Canal; on wood from the coniferous forests of the 'taiga'; and on raw materials such as flax and wool from the south. Recently there has been great development of electricity—generated both by water-power and in plant which burn peat from bogs in the surrounding country.

NEVSKY AVENUE, LENINGRAD
Planet News

NALUT, AN OASIS IN NORTH-WEST LIBYA. *Dorien Leigh*

Leningrad is the chief western port of the U.S.S.R., except for about three months in the winter, when the Gulf of Finland is frozen and Murmansk takes its place. Its most important export is timber, and the port is equipped with very up-to-date machinery for loading the wood into the ships.

See also R.S.F.S.R.

LEVANT, *see* SYRIA AND LEBANON.

LIBERIA, *see* GUINEA LANDS.

LIBYA. This vast stretch of North Africa, which also includes Tripoli, lies between Tunisia in the west and Egypt in the east, and stretches southward across the Fezzan and the Libyan Desert to the Sahara and the Sudan (*see* Map, p. 5). In its north-western corner is Tripolitania, and in the north-east, bordering on Egypt, is Cyrenaica. For long, Turkey ruled Libya; but in 1912 it became part of the Italian Empire, and the Italians spent much money and labour in settling colonists there after the First World War. Much of their work was undone in the Second

World War, when northern Libya became a battle-ground.

The most favourable areas for new settlement were in Tripolitania, where a narrow coastal plain is backed inland by a rolling, treeless plateau, rising slowly to the mountains. The Italian colonists grew crops, such as tobacco, olives, and dates, and a little grain, especially barley, and, in the better-watered oases, a variety of fruits. They planted trees in the shifting dunes of the coast to hold the sand together so that it should not blow over the cultivated areas. Southwards and eastwards of the mountains of Tripolitania lies a mountain desert, mainly of limestone rocks. Eastward this merges into the Fezzan, an arid region of bare stony plains, scrub-covered hills, and rocky mountain ridges, on which a little vegetation grows in the short wet season. In this region there are several large and much-populated oases, fertile and rich with palms and gardens. The chief of these, Murzuq, is reputed to have a population of over 5,000.

The large peninsula of Cyrenaica is cut off from Tripolitania by a stretch of desert which comes up to the shores of the Gulf of Sidra. In northern Cyrenaica, a ridge of hills, rising to a high tableland, comes right up to the coast. This is called the Green Mountain, because both the tableland and the northern slopes are covered with thick, low forest. There is plentiful rainfall, and the region is favourable for cultivation and for rearing goats and cattle. On the southern slopes, the rainfall decreases rapidly, and apart from some patches of cultivation, the land is suitable only for herdsmen—and these have to bring their herds north as the drought of the summer increases. Farther south is the great sandy Libyan Desert, which is much drier than the Fezzan. Kufara, its largest oasis, is less rich than Murzuq. Round the oases, and everywhere which is not entirely desert, sheep and camels are kept in wandering herds, searching for grazing (*see* DESERTS).

Apart from the Europeans, who are to be found only in the towns of the coast, the people of Libya are BEDOUIN herdsmen (q.v. Vol. I). The majority of them live a nomadic life to a greater or lesser degree. They move where there is pasture to be found, making their tent encampments in the hollows and on the slopes of *wadis* (dry water-courses). They market their goods in the towns, and buy there the few things they need; but otherwise the *bwardi* (tent-dweller) and the *hardu* (town-dweller) have little in common and do not mix.

Tripoli, the chief port and the most important town, is the centre of a native cloth-weaving industry. It has an important market, for it is the terminus of caravan routes from the east and south. It is a very old town. There is still to be seen an arch built in the 2nd century A.D. by the Roman Marcus Aurelius; and the Moorish conquerors in the Middle Ages have left much evidence of their domination, including many mosques. Benghazi, the second town of Libya, is on the Gulf of Sidra in Cyrenaica. It stands on the site of the classical town of Berenice; but it did not grow up again until the 15th century. The Italians developed it into a modern European town, and it has now a very mixed population of some 22,700. Since 1951 Libya has become an independent kingdom. Its population, which is difficult to estimate accurately, is probably about one million.

See also Vol. I: SAHARAN PEOPLES.

LIECHTENSTEIN. This is an independent sovereign state lying between south-western Austria and Switzerland, and bounded by the right bank of the Rhine. It is about 62 square miles in area, and has a population of nearly 12,000. In the 18th century the principality of Liechtenstein was part of the HOLY ROMAN EMPIRE (q.v. Vol. I). It became an independent state under its own prince in 1866.

LIECHTENSTEIN: AT THE FOOT OF THE ALPS
Mondiale

Nearly all the people are German in origin and speak German.

Most of the wealth of the country comes from its farms, orchards, vineyards, and forests. Cattle are reared on the Alpine pastures. Vaduz, the capital, has a few small industries, such as cotton-weaving and spinning, leather goods, and pottery. Liechtenstein has for some years been incorporated in the Swiss Customs Union, and now uses Swiss currency.

See also SWITZERLAND.

LIGHT. The question of how light travels through space has puzzled men for centuries, and has not yet been completely answered. What is now certain is that light is just one form of RADIATION (q.v.), which also includes such very different things as X-rays, heat, and wireless waves. It is believed that all electromagnetic radiation consists of small packets of energy in the form of waves, travelling through space at a speed of 186,000 miles a second. If the 'wave-length' or distance from crest to crest of these waves is anywhere between two certain sizes, our eyes 'see' them as light; if they are larger or smaller, they are invisible to us, although we may be able to detect their presence in other ways.

The ancient Greeks thought that light travelled instantaneously by means of tiny particles emitted from the source, and that 'seeing' occurred when these struck the eyes. GALILEO (1564–1642) (q.v. Vol. V) could not believe in instantaneous travel, and tried to time the speed of light; but his methods were far too crude to succeed. In 1675, however, a Danish astronomer, Roemer, was more successful. From careful observations of the eclipses of Jupiter's moons he came to the conclusion that light travels through space at 180,000 miles per second (*see* ASTRONOMY, MEASUREMENTS OF). It had still to be discovered, however, how and in what form light travelled.

Sound was known to travel in waves, and it was thought that light might very well do the same. However, NEWTON (1642–1727) (q.v. Vol. V), who added greatly to our knowledge of light, suggested that it was made up of particles. At that time it was thought that light travelled only in straight lines and was unable to bend round behind an obstacle in its path. Newton could not believe that this property of 'diffraction', as it is called, would be absent from light waves when it occurs with sound and all other waves (*see* WAVE MOTION). But particles, he saw, would move in straight lines and be intercepted by an obstacle; they would rebound from a mirror, or be 'reflected'. On the other hand, with the particle theory it was difficult to explain why, when light enters a transparent medium like water or glass, part of its rays are bent, or 'refracted', and part reflected. Also, when white light is refracted, it spreads out to form bands of all the colours of the rainbow—and it had to be assumed that there were different kinds of particles for the different colours.

Because of these difficulties, other scientists of the time disagreed with Newton's suggestion and held that light travelled in the form of waves. Controversy over the two theories went on until the 19th century, when the work of scientists in England and France moved the balance in favour of the wave theory. Their experiments showed that light could, after all, bend round an obstacle, but only to a very small extent. They argued that the amount of bending was related to the length of the wave, and since even the longest light waves (red) were only 0·0007 of a millimetre long, diffraction was very small also (*see* COLOUR). The wave theory explained other properties of light, too. If two small sources of light are placed close together, when their rays are projected on a screen they produce alternate bands of light and dark, called 'interference bands'. A similar effect can be seen with waves or ripples on water. The theory also explained what is called 'polarization'—the effect on light of certain crystals, such as tourmaline. One piece of tourmaline looks to be quite transparent to light; and so do two pieces if placed one behind the other with their crystals parallel as shown in Fig. 1 (*b*). But if one piece is slowly rotated to the position shown in (*c*), the amount of light transmitted will gradually decrease until no light passes through and the crystal appears

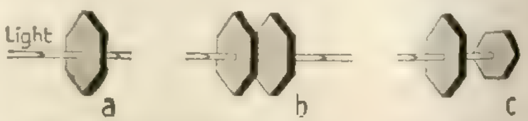


FIG. 1. THE POLARIZATION OF LIGHT BY TOURMALINE

opaque. Fig. 2 shows how this can be explained if we suppose that light is composed of waves, and that these waves are 'transverse' or across the direction of travel, rather than 'longitudinal' or along that direction, as sound waves are.

Light [illegible] to be polarized when it has passed [illegible] substance such as tourmaline [illegible] stopped all its waves except those in a cer[illegible].

[illegible]XPLANATION OF POLARIZATION

A [illegible] in vertical transverse waves could get [illegible]al slit, but a snake moving in horizontal [illegible] could not (a). The snake could get [illegible] slits (b), but if the second slit were [illegible] would be stopped. Tourmaline behaves like [illegible] letting through only those waves of light which are in the same plane

In [illegible] and again in 1850, more accurate expe[illegible] corrected the figure for the speed of l[illegible] across a measured distance on the eart[illegible] to approximately 186,000 miles a se[illegible] figure accepted to-day.

In [illegible], Clerk Maxwell (1831–79) published his El[illegible]o-magnetic Theory of Light, suggesting that [illegible] of light were just one particular examp[illegible] of electric and magnetic disturbances which [illegible] travel in wave form through space. In general this theory agreed with all that was known at that time about the behaviour of light. There remained the question of what medium carried the waves through space, since waves of nothing seemed an impossibility. To explain this, it was necessary to assume that an invisible substance called 'ether' existed everywhere throughout the universe in all forms of matter, in the atmosphere, and beyond it, in space. The next step was to try to measure the speed of the earth's movement through the ether, since it was absurd to suppose that its vast expanse should move along with our own relatively small planet.

In 1887 two scientists, Michelson and Morley, made a famous but unsuccessful experiment designed to measure the speed of the earth through ether. It takes an oarsman longer to row 100 yards down a river and back against the current than it does to row 100 yards across the stream and back again (Fig. 3). In the same way it was supposed that it should take a ray of light longer to travel to a mirror and be reflected back to its source if the direction of its movement is parallel to the flow of ether past the earth, than it should if its path lies across the flow and back. In the Michelson–Morley experiment, two rays of light were sent out simultaneously at right angles and reflected back over equal distances from two mirrors. No difference at all could be detected in the speed of the two rays, nor have even more delicate experiments since given any other result. This suggested that ether did not exist, and so the wave theory could no longer be accepted as a complete explanation of the nature of light, nor, indeed, of any other form of radiation.

At the beginning of the present century, then, the position was that, while certain properties of light, such as diffraction, interference, and polarization seemed to require waves to explain them, other properties seemed to need particles —and, in any case, no wave-carrying medium could be found. To-day physicists no longer try to solve the problem in terms which can be pictured by the imagination, like waves or particles; the question is dealt with by a form of mathematics known as 'Wave Mechanics'. The problems handled cover a wider field than light alone, and are examined in the articles on RADIATION and the QUANTUM THEORY (q.v.).

The Michelson–Morley experiment and the investigations that followed it gave us yet more information about the properties and behaviour of light. It was discovered, mainly from this experiment, that light always reaches an observer at the same speed, no matter with what speed or in what direction he and the source of light are moving in relation to each other. This seems to be impossible from the point of view of 'common sense'; but the truth of it has been proved beyond all doubt, both by experiment and by mathematics. The light from a distant

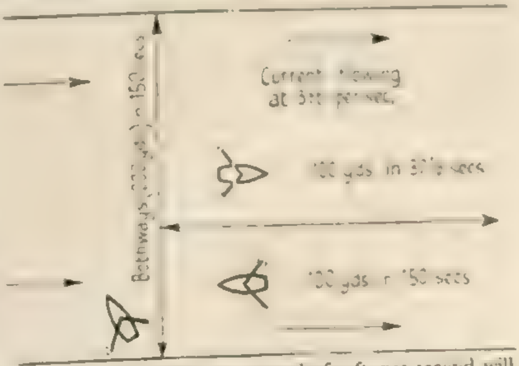


FIG. 3. A man rowing at a speed of 5 ft. per second will take 37½ secs. to row 100 yds. downstream and 150 secs. to row back, i.e. 187½ secs. for the whole 200 yds. But to row 200 yds. across the stream and back again will take only 150 secs.

star will strike the earth at exactly the same speed whether the earth and the star are rushing towards each other with immense speed, or whether they are rushing apart.

It was then discovered that what had always been believed about the combination of any two speeds was incorrect, and that, in fact, when one speed is superimposed on another:

(i) the resulting speed is always less than the two speeds added together. For example, a stone shot forward from a catapult at 60 m.p.h. from a train moving at 60 m.p.h., leaves the catapult at just *under* 120 m.p.h. relative to the ground; and

(ii) the resulting speed can never be faster than the speed of light—and it can only be as fast if one of the two speeds is equal to the speed of light itself. In other words, no form of energy or matter can move more quickly than light.

With the relatively slow speeds of everyday life, the differences due to (i) are far too small to be measured (an aircraft travelling at 600 m.p.h. covers only 1/6th mile per second—as compared with light's speed of 186,000 miles per second). But astronomers, dealing perhaps with light coming from nebulae travelling at 1,000 miles per second, or physicists concerned with particles shooting out of radio-active bodies at terrific speeds, find it very necessary to take these considerations into account.

How these conclusions have revolutionized our ideas of the universe is described in the articles on RELATIVITY, SPACE, and TIME.

LIGHTNING, *see* THUNDER-STORMS.

LIGNITE, *see* COAL.

LIMA. The capital of Peru, on the Pacific coast of South America, was founded in 1535 by Francisco PIZARRO (q.v. Vol. V), soon after the Spanish invaders had broken the resistance of the native people of Peru, the INCAS (q.v. Vol. I). Pizarro called his new city Ciudad de los Reyes (City of the Kings), because it was founded on the day of Epiphany; but before long it became known as Lima, a corruption of 'the place of Rimac', the god of the river on which the city stands.

Lima was for some time the chief city of South America, the seat of the Spanish Viceroy and of the Archbishop. It was a rich and magnificent city with a cathedral, fine stone buildings, and the

THE PLAZA DE AMAS, LIMA. *Dorien*

University of San Marcos, founded in 1551. In its older streets to-day there are still many traces of the great days of the Spanish Empire—the house where the INQUISITION (q.v. Vol. I) sat, as well as the mansions of the Spanish grandees, magnificent buildings with delicate ironwork and beautiful carvings. In a small suburb on the north bank of the River Rimac is one of the largest bullrings in the world, built in 1768, and still used for BULLFIGHTS (q.v. Vol. IX).

The huge Plaza de Amas is the main square of Lima. One side of this is occupied by the Cathedral; along another passes the principal street, the Calle de la Union, which runs from the railway station to the River Rimac. There are four great markets in Lima, one of which is considered to be the best-designed market in South America. Close inland from the city rise the high, narrow, rugged ridges of the Andes foot-hills, bare and forbidding, with the snow peaks of the high Andes ranges far beyond. The city lies in the rain shadow of the mountains and gets little rain; but winter moisture is brought in plenty by a heavy wet mist called the *garva*, which makes the orchards and gardens fruitful.

Seven miles downstream, at the mouth of the Rimac, is Callao, the rather squalid, uninteresting port of Lima. It is connected with the capital by train, tramcars, and a fine motor road.

See also PERU.

LIMESTONE. Limestones are sedimentary rocks. Some are of organic (animal or plant) origin; others are the result of chemical processes.

1. ORGANIC LIMESTONES consist mainly of calcium carbonate (carbonate of lime), and are formed of the shells or skeletons of organisms that live in water. Foraminifera, corals, sea lilies, crustacea, and molluscs (shell-fish)—all build shells of calcium carbonate which, when the animals die, sink to the bottom of the sea or lake, forming limestone beds. Some kinds of seaweeds secrete calcium carbonate, and this piles up on the sea bottom, helping to make limestone. As all these organisms live in clear water, organic limestones are generally very pure, being free from sand and mud.

'Chalk' is a comparatively soft, white, fine-grained, earthy limestone, made mainly of foraminifera (*see* PROTOZOA, Vol. II). Carboniferous limestone (that is, limestone formed in the Carboniferous Age, perhaps some 250 million years ago) in some places is made entirely of the skeletons of sea lilies, while in others it is mainly of fragments of CORAL (q.v. Vol. II). 'Oolitic limestones' (from Greek *oon*, egg, and *lithos*, stone) are made of grains put together so that the rock resembles fish-roe: hence the name 'egg-stone'. Some oolitic limestones, especially the larger-grained types, are supposed to be organic in origin, the grains being perhaps built up by small organisms.

A SEA LILY

2. CHEMICALLY FORMED LIMESTONES are formed when water containing dissolved calcium evaporates. Many oolitic limestones are supposed to have been formed in this way, the limestone being deposited in layers round minute fragments of shell or sand.

Stalagmites and stalactites (*see* CAVES) are types of chemically formed calcium carbonate, as are tufa and travertine, the limestones that are deposited by calcareous (or petrifying) springs. Tufa is light and spongy. Travertine is often compact enough to be used for building-stone—and, indeed, was used considerably in the building of Rome.

'Magnesian limestones' and 'dolomites' are rocks in which part of the calcium carbonate of the original limestone has been replaced by magnesium carbonate. Salts of magnesium are contained in sea-water, and the process of dolomitization in which the magnesium is introduced to the limestone may take place in the sea, large areas of dolomite being formed. Sometimes the salt water penetrates limestone by cracks and fissures, and then patches or veins of dolomite are found. Magnesian limestones and dolomites tend to be yellowish or brownish in colour. They are less soluble than limestone, and more resistant to weathering.

'Gypsum' is sulphate of lime, usually occurring in patches in marl and clays. Large quantities of it are being deposited in the DEAD SEA (q.v.) as the waters of that sea evaporate. 'Alabaster' is a pure form of it.

See also MINERALS; ROCKS, Section 3.

LISBON. The capital of Portugal faces south and south-east across the Mar da Palha, the broad estuary of the River Tagus. It is built about 9 miles from the sea, on and between two groups of hills which rise abruptly above the river and are divided by a broad valley. Several earthquakes, especially the disastrous one in 1755, have destroyed most of the old Moorish town and the splendid buildings of the 16th century, when Lisbon was one of the richest towns in Europe.

East Lisbon is the oldest part of the town. It is on the slopes of a steep hill, on the summit of which stands the old citadel of Castelo de S. Jorje (Castle of St. George). Precipitous flights of steps and steep tortuous alley-ways lead up from the river-side to the slums, to the cathedral, and to the old citadel. West Lisbon, the new quarter, built in the 18th century after the great destruction by earthquake in 1755, is formal in layout. The new city was rebuilt to a regular pattern, in which some streets are occupied almost entirely

LISBON
The Castle of St. George stands on a hill rising steeply above the city

by one trade. In the days when Portugal was building an empire, Lisbon was a great slave market and a world-known trading place. Recently it has become important as an international airport. It has a population of some 709,000 and is about twice the size of Oporto, the next largest city in Portugal.

See also PORTUGAL.

LITHUANIA. The Lithuanian Soviet Socialist Republic is the most southern of the Baltic republics of the U.S.S.R., and has a population of about 2½ millions (*see* Map, p. 459). From 1920 to 1940 it was an independent republic. It is primarily an agricultural country, growing cereals, potatoes, flax, and sugar-beet, and keeping dairy cattle and pigs. Forests cover considerable areas, and there are many sawmills.

Memel, on the Baltic, is an open port all year. Kaunas was the capital from 1920 till 1939. Vilna, the ancient capital of Lithuania since 1323, was put within the boundaries of Poland in 1920, but was restored to Lithuania in 1939. It is an important market town and railway junction, and is also a very picturesque old town, with beautiful medieval houses and streets.

See also U.S.S.R.
See also Vol. I: LITHUANIANS.

LIVERPOOL. The city of Liverpool, with a population of about 800,000, is the centre of Merseyside—a region of industrial towns, such as Birkenhead, St. Helens, Widnes, and Runcorn, of residential towns like Southport, Formby, and Hoylake, and of an exceptionally fertile farming area, of which Ormskirk is one of the chief market towns.

Liverpool, and Bootle which continues it seaward, line some 14 miles of the right bank of the Mersey. On the opposite side of the river, Birkenhead and Wallasey stretch along 8 miles of the river bank. An electric railway, a road tunnel (*see* MERSEY TUNNEL, Vol. IV), and many ferry-boats link the two sides of the river. The growth of Liverpool, the second port of Great Britain, has been responsible for the development of Merseyside. Liverpool was originally a fishing village with a sheltered harbour in the bottle-shaped estuary of the Mersey. Later, it became the port for Ireland; but it was not until the early 17th century, when it began to take part in the trade with the West Indies, that it became of real importance. Trade in tobacco, sugar, cotton, and slaves brought great wealth to the town. Like London, it became an 'entrepôt'—that is a port which re-exports a considerable part of the goods which are brought into it. Docks and enormous warehouses were built. Now it is the chief port for the export of the manufactured goods of the north, and from it run many of the main passenger lines to the U.S.A., Africa, and the Far East. It is also one of the big centres of British shipbuilding.

Liverpool expanded very rapidly and with very little town planning. This has left the city a legacy of large congested slum districts, which the authorities are clearing bit by bit. Some parts of the centre of the town are well planned and beautiful; but many of the streets tend to be gloomy and monotonous. Liverpool has a university, and a Roman Catholic and an Anglican Cathedral, though neither of these latter is yet completed.

During its growth, the city has absorbed emigrants from all parts of the British Isles, in particular from Ireland. Many of the Liverpool Irish are descendants of those who came over in the second half of the 19th century.

See also ENGLAND.

LOESS, *see* ROCKS, Section 3 (*a*). *See also* Vol. VI: SOILS.

LOFOTEN ISLANDS, *see* NORWAY.

LONDON is the capital of England and the largest city in the world. In many places it measures nearly 30 miles across, and there are almost nine million people living there. It is so large that even those who have lived in London all their lives still find parts of it which are strange to them.

London is very varied: it is not a magnificent, dramatic capital, like some, for it has grown up during many centuries and has never been laid out afresh. Many of its finest buildings are not well displayed, but are half-hidden in mean streets or dull, ordinary buildings. The chief buildings are of grey Portland stone—a stone which in the damp English climate changes to queerly varied colours; so that the buildings have interesting shadows and high lights, making even greater the contrast between old and new. The River THAMES (q.v.), with which much of the city's history and prosperity are linked, flows through the centre of London.

There are really three Londons: the City of London, the oldest part; the County of London, a much larger area governed by the London County Council; and Greater London, which includes the outlying suburbs and towns that have gradually become absorbed into London.

The City, as it is called, was once a river-side town surrounded by walls, with country-side all around and plenty of open space inside: now it is one of the most important business centres in the world, teeming with people in the day-time, but practically deserted at night. The City is still quite separate from the other two Londons, though it is surrounded by them: it has its own Corporation and Charter, and has for years sent its own Members to Parliament. An interesting ceremony remains as a reminder of the curious position of the City of London: when the King wishes to pay an official visit there, he has to ask permission of the Lord Mayor, and to be received in ceremony at Temple Bar, one of the boundaries of the city. Thus the independence of the City of London is maintained, even in modern times.

The Tower of London, the most important building in the City, has been the scene of many imprisonments and executions since it was first built by the Norman king, William the Conqueror. It has never been the home of the kings and queens of England, who have always held their court at Westminster—a village upstream. This village has grown so much through the centuries that it is now part of London and

LONDON IN THE 17TH CENTURY

The spire of Old St. Paul's, the Tower, Old London Bridge, and Southwark Cathedral on the south bank can be identified. Westminster in the foreground is a small village. The river was a busy thoroughfare in those days. Engraving by W. Hollar (1607–77)

THE CITY OF LONDON AFTER THE SECOND WORLD WAR

St. Paul's Cathedral towers above vast areas devastated by bombing. To the west (on the left) is the tower of the Old Bailey and Blackfriars road and railway bridges. To the east is Cheapside, with the tower of St. Mary le Bow, leading to the Bank of England (on the extreme right). *The Times*

is, in fact, an important central area of the capital. In it are the two Houses of Parliament, Westminster Abbey, the Government buildings, and Buckingham Palace, the royal residence since the early 19th century.

London was not always the most important city in England: King Alfred, for instance, held his court most of the time at WINCHESTER (q.v.). When the Romans came to Britain, London was nothing but a small river settlement. The Roman legions sent by the Emperor Claudius in A.D. 43 established an outpost of the Roman Empire there, and called it Londinium. Londinium remained a Roman city for nearly 400 years until the Romans finally left Britain. Nothing much is known about the end of Londinium, except that the fine buildings fell to ruin, and for many centuries much of the space enclosed by the old Roman wall must have been open ground, covered with ruins. The Danes sacked the city several times, and it was rebuilt as a jumbled mass of wooden-walled, thatch-roofed houses, so inflammable that fires frequently laid it waste.

During the Middle Ages, London began to grow important and rich, and to expand beyond its walls into 'suburbs' outside. The city, rich and prosperous, and protected from the east by the great fortress, the Tower, was a centre of commerce. By the 16th century the nobles had begun to build their palaces along the north bank of the river, so that soon the river bank was inhabited all the way from London to Westminster—about 2 miles. The south bank too was built on—though this was never a fashionable district, and is to-day mainly industrial. The Thames was for many centuries the main route of communication between London and Westminster and other villages on its banks. Now it is spanned by a number of bridges, and large ships cannot pass upstream beyond London Bridge.

Tudor London was built mainly of wood, with houses so close together that their overhanging roofs nearly met across the narrow streets. There was no drainage system nor refuse collection, the streets were unpaved and uncleaned, and disease was very common. In 1666 the Great Fire destroyed a large part of the city—a terrible disaster at the time, though, in fact, it cleared away much which was better destroyed. The new houses were built mainly of brick. Sir Christopher Wren drew up a grand plan for a new London, but the City Council would not accept it; and so the new London had the same crooked streets as the medieval city, and was even more overcrowded.

During the 18th and 19th centuries, London continued to spread: villages, once remote from the city, were swallowed up and became a part of the capital, causing much confusion in London's government. There was no authority concerned with this new, larger London, until 1855, when a Board of Works was set up which lasted until 1889. Then Parliament made London a separate county of England.

The County of London is made up of twenty-eight boroughs, each with its mayor, aldermen, and councillors. The County Council is the unifying body which deals with education, poor relief, hospitals, parks, sewerage, and the care of the sick and the insane. It operates from County Hall in Westminster, on the south bank of the river, opposite the Houses of Parliament.

Greater London is not a definite area, as are the City and the County of London: it is a region of about 20 miles radius from Oxford Circus, and is surrounded by a 'green belt' beyond which London is planned to spread no farther. All its parts are now linked by an excellent system of buses, trolleys, and underground trains—said to be the best in the world.

London's name stands usually for commerce, trade, and finance; but it is not only famous for its great port, its Stock Exchange, and its banks: it also takes its place with other great capitals as a musical and artistic centre. Its museums, art galleries, and scientific institutions are world-famous. The bombing raids of the Second World War destroyed much of its beauty and historic interest; but they also did away with many badly crowded areas. A new London has been planned, with more open spaces and wide, spacious roadways. It is hoped to solve the problems of overcrowding by re-housing many people in 'satellite' towns in the surrounding country-side, where healthier living conditions are to be found.

See also ENGLAND.

LOS ANGELES. The words mean 'The Angels', and are all that is left of the name given the town by its Spanish discoverers in the 18th century—'The Town of Our Lady, Queen of the Angels'.

To most people Los Angeles at once suggests

the cinema. Its rise—the most meteoric rise of any city in the 20th century—is certainly due mainly to the world demand for moving pictures. In 1900 Los Angeles had 100,000 inhabitants: while to-day it has nearly $1\frac{1}{2}$ millions, and is easily the biggest city on the Pacific side of the U.S.A., being twice the size of San Francisco (q.v.). Its suburb, Hollywood, where more than two-thirds of the world's films are made, is the most famous film centre in the world.

Los Angeles is fortunate in its climate and situation. The earliest motion pictures had to be made in sunlight, and Los Angeles has almost constant sunshine. Then, beyond the city there are miles of open, almost desert country, with wide plains and rugged hills, giving a variety of scenery close at hand.

But there are other reasons for the development of Los Angeles into a great city. It has rich oil wells and great industries manufacturing petroleum products, glass, and chemicals. It is also a market centre for fruits, vegetables, livestock, dairy and agricultural produce, and there is meat-packing. There are hundreds of fine schools and churches, and many parks, theatres, concert halls, museums, and art galleries; for its development, although very rapid, has not been haphazard or incomplete.

See also United States of America.
See also Vol. IX: Cinema, History of.

LOUISIANA, *see* United States of America.

LUXEMBOURG. The Grand Duchy of Luxembourg has an area of about 1,000 square miles. Its greatest length from north to south is about 50 miles, its greatest width 37 miles. The Moselle, the Our, and the Sure (Sauer) separate it from Germany to the east. France lies to the south, Belgium to the west (*see* Map, p. 160).

In 1831, when Holland and Belgium became separate countries, the grand-dukedom of Luxembourg was governed by the kings of Holland; but when, in 1890, there was no male heir to the throne of Holland, Luxembourg became independent. It has now a population of 300,000, most of whom are Roman Catholics.

THE CITY OF LUXEMBOURG. *Do: n*

Most of Luxembourg is hilly and rocky, with little fertile soil. Potatoes and oats are the chief crops, and the cultivation of flowers for export is an important occupation. There are few domestic cattle, but there is plenty of wild game, such as deer and hares.

The country is rich in minerals. In the south-west, there is a very productive iron-field, but coal has to be imported to process the ore. Steel manufacture, cement-making, tanning, and linen and woollen manufactures are the main industries.

Luxembourg, the capital, is the only real city. The old part is on a plateau bounded on three sides by cliffs dropping to two deep river valleys. Both banks of these rivers are lined by distilleries, breweries, and other industrial buildings. In the old city there are fine buildings, and on the site of the old fortifications broad boulevards and parks have been laid out.

M

MACKENZIE RIVER. In the early summer of 1789, a year marked in world history by the French Revolution, a Scottish fur trader in North America, by the name of Alexander Mackenzie, set out on a voyage which made him famous. Leaving the trading-post of Fort Chipewyan at the head of Lake Athabaska, he sailed with a crew of French Canadians and Indians down the Slave River, crossed the treacherous Great Slave Lake, and, at its western end, entered a broad river which no white man had previously explored. He expected that this river would lead him to the Pacific, and when he reached an ocean and found that it was the Arctic, he called his discovery River Disappointment. But other fur traders always spoke of it as Mackenzie's River, and it is this name which has survived (*see* Map, p. 318).

The Mackenzie is the longest river in Canada, and with its tributaries, the Liard and the Bear, and its head-rivers, the Slave, the Peace, and the Athabaska, it gives several thousand miles of waterway. The MISSISSIPPI (q.v.) is the only river in North America which is longer, and like that river, the Mackenzie forms a very large delta. The delta of the Mackenzie covers an area about half the size of England, and its countless rivulets and thousands of small lakes are a glorious sight from the air on a sunny summer's day. But, unlike those of the Mississippi, the banks of the Mackenzie are not dotted with populous towns. Icebound for the greater part of the year, the river is navigable only from June to October, and the territory through which it flows is very thinly populated, mainly by AMERICAN INDIANS and ESKIMOES (q.v. Vol. I). The white men are chiefly trappers, fur traders, engineers, or prospectors, with a few scattered doctors, missionaries, and Canadian 'Mounties' (*see* CANADIANS, Vol. I). In summer conditions are pleasant; for at places like Aklavik, 80 miles from the sea, where the Arctic night descends for many weeks during winter, in summer the sun shines for 24 hours of the day, the earth is green, and the river blue. Valuable cargoes are carried by the

AKLAVIK ON THE MACKENZIE RIVER, NORTH-WEST TERRITORIES
High Commissioner for Canada

river—mineral ores, oil, pitchblende (containing radium) from the Great Bear Lake, and, above all, furs. But this seasonal transport has proved inadequate; and the Mackenzie country is now crossed by several air-lines, destined to play an ever-increasing part in the development of its rich resources.

See also CANADA.
See also Vol. VI: FUR HUNTING AND TRAPPING.

MADAGASCAR. This island, one of the largest in the world, lies off the east coast of Africa (*see* Map, p. 5). It is a French colony. Most travellers come to Madagascar from Africa—and they find it like stepping into a new world. In Africa there are many kinds of wild animals and poisonous snakes; in Madagascar the lemur is the only wild creature, and there are no deadly snakes at all. In Africa the huts are round; in Madagascar they are square. In Africa the people are black with short kinky hair; in Madagascar they are brown with long and often straight hair. Madagascar is in many ways more akin to Asia than to Africa, and most of its people came, many centuries ago, from Malaya, and imposed their language and culture on the whole island.

The coastal area is low-lying, hot, and steamy; and the vegetation is tropical, with great raffia palms, mango-trees, and graceful bamboos. There are butterflies everywhere, and budgerigars, blue jays, and cardinal birds. The greater part of the island, however, consists of a plateau 3,000 to 4,000 feet above the sea, on which great herds of cattle graze. Many of the valleys are irrigated, and rice is grown in them.

Madagascar is thinly peopled—there are approximately four millions on the island; but the population gets denser with distance from the coast, and in the interior there are villages every few miles. On market-days there is great activity, and bananas and mangoes, sweet potatoes and rice, grass mats and earthenware pots, cattle and hides are all on sale.

Antananarivo, the capital, is about the size of Reading or Rochdale, and is built on the sides of a ridge that rises steeply out of the rice-fields. On the highest point is the old royal palace, which the French turned into a museum when they conquered the island in 1895. In the streets of Antananarivo there are motor-cars and bullock-carts, and people in Paris-made suits mingle with others wearing *lambas* round their shoulders. The *lamba* is a kind of shawl and the national garment. It is usually white, but the *lamba-mena*, which is reserved for festive occasions, is as many-coloured as a Scottish tartan.

A NATIVE VILLAGE IN MADAGASCAR
Dorien Leigh

The French have built roads all over the island, even between quite small villages, so that travel is fairly easy. Some roads are metalled and can be used in all weathers; others are just earth-roads that have to be repaired after the rainy season. There are about 500 miles of railway. By French colonial policy, French citizenship is granted to a certain number of individuals. This is a coveted distinction which brings privileges and opportunities. It has, however, a disadvantage in that it tends to break the unity of the people. French colonial

policy encourages also the spread of French culture. French is the official language and education is on the French model.

The main exports of Madagascar are rice, meat, and hides, together with increasing quantities of vanilla, coffee, and mica. The coast as a whole is inhospitable, but there are two considerable ports, Tamatave on the east and Majunga on the west, and one important naval base, Diego Suarez, on the north.

MADEIRA. The name is generally used to include the island of Madeira, the smaller island of Porto Santo, and some uninhabited islets. Like the AZORES (q.v.), they belong to Portugal. They lie in the north Atlantic off the west coast of North Africa, south-west of Portugal, and have a pleasant sub-tropical climate with dry summers and moderately wet winters (*see* Map, p. 322).

Madeira is very mountainous. Pico Ruivo (the Red Peak) rises to over 6,000 feet. The country round it is seamed and gashed by deep ravines, and long lava reefs jut out to sea, with sheltered sandy bays lying between them. Though formerly there were forests everywhere, now these are mainly confined to the upper mountain slopes, where chestnuts and laurels flourish. A good deal of grain is grown, and from the vineyards come the grapes which are made into world-famous Madeira wine.

The island is densely peopled, and the standard of living is very low; but to the tourist who disembarks at Funchal, the capital, and visits the sunny, beautiful island, buying the embroideries, straw-hats, inlaid woodwork, and cane baskets for which Madeira is renowned, it seems a very pleasant place indeed.

MADRID. The capital of Spain lies 2,372 feet above sea-level, near the centre of the Iberian Peninsula. Originally it was a Moorish fortress occupying a steep-sided hill-site surrounded on two sides by the River Manzanares, a tributary of the Jarama which flows south to the Tagus. It was known as Majrit to the Moslem world of the 10th century. After its capture from the Moors, Charles V made it his country residence and built a hunting-lodge there. It was not until the 16th century that Philip II made it the capital of the country. The warring kingdoms of Spain were united for the first time, and the central position of Madrid made it, from the political point of view, a good choice for the capital. It had not many other advantages—for the climate is unpleasant, the river unnavigable, the neighbouring country-side poor and infertile, and the town was remote from the main centres of population. Outside Madrid, in the mountains, Philip built a large monastery known as the Escurial, where from the windows of his room he could gaze across the bare plains of New Castile.

MADRID, LOOKING NORTH-WEST TOWARDS THE GUADARRAMA MOUNTAINS. *The Times*

To-day, Madrid is the centre of the road and rail systems of the country. It is an important industrial and manufacturing centre, and has a population of 1,609,000. The square form of the old city with its part-earth, part-brick walls can still be traced. The walls were 20 feet high and were pierced by five gates (*puertas*) and eleven doorways (*portillos*), but only two *puertas* and one *portillo* now remain. The centre of modern Madrid is the Puerta del Sol, which marks the site of the east gate of the old town and has a huge embossed sun. The ten main streets of the new town branch outwards from it. The new town has broad streets and squares, boulevards, villas, and gardens. The Manzanares River,

[illegible] than a stream in summer, is [illegible]

In summer Madrid is [illegible] hot; but the [illegible] In winter the winds [illegible] and skating in the Buen Retiro Park is a popular pastime.

[illegible]

[illegible]

MAELSTROM, [illegible]

MAGNESIUM, *see* [illegible]

MAGNETISM is a general term used to describe the properties and behaviour of a magnet. The earliest known magnet was the mineral 'lodestone' which occurs naturally in the earth. This has the following properties: (a) it attracts tiny pieces of iron; (b) a piece of iron suitably stroked by it is itself turned into a magnet with similar properties; (c) it possesses 'polarity', which means that there are in it two points, called 'poles', that show magnetic properties such as attracting iron filings much more strongly than any other part. If a piece of lodestone is suspended in such a way that it can swing freely, it will always come to rest with one particular pole pointing north and the other pointing south. Furthermore, if two pieces so suspended are brought close to each other, it will be found that the two north-seeking poles (or 'north poles', as they are called) tend to swing away from each other, but that each tends to swing towards the 'south pole' of the other. In other words, unlike poles attract but like poles repel. If lodestone is cut up into smaller pieces, each of these will become a magnet, having a north and south pole of its own.

To-day all these properties are usually demonstrated by artificial magnets, and lodestone tends to be a museum exhibit, though it has its use as iron ore. Magnetic effects can be produced in all substances, but the difference in behaviour between iron and its alloys and everything else is so marked that for practical purposes we can say that iron, or an iron alloy, is the only material that can be affected by a magnet or made into one. A magnet usually has its north pole marked by colour or letter.

The properties of lodestone were known to our ancestors both as a mystery and as a very practical means of direct[illegible] the use of a swinging magnetic needle in the form of a mariner's compass, having been used for seven centuries as an indispensable aid to NAVIGATION (q.v. Vol. IV). Ma[illegible] have been made to explain the b[illegible] a magnet. In his famous book, *De* [illegible] lished in A.D. 1600, William Gi[illegible] he took a large lump of lodestone [illegible] into a sphere. Then he showed th[illegible] netic needle near its surface acte[illegible] way to the mariner's compass [illegible]. From this he concluded that the [illegible] a huge ball of lodestone with pole[illegible] and south. Since then, scientists ha[illegible] research on what is now called 'ge[illegible]' or 'terrestrial magnetism'; and unt[illegible] was believed that the main magnet[illegible] Earth resulted from its having a m[illegible] (*see* Fig. 2)—though the magnetic po[illegible] 300 miles away from the geograph[illegible]

The explanation of the way in wh[illegible] nent magnet affects a magnetic ne[illegible] in the idea of a 'field of force'. Wh[illegible] iron jumps towards a magnet there [illegible] be something happening in the spa[illegible] them. In fact, all round a magn[illegible] district in which magnetic forces ar[illegible] and this is called a 'field of force' o[illegible] field'. Its shape can be shown by [illegible] simple experiment. If a flat piece [illegible] put over a straight magnet and spr[illegible] iron filings while the paper is gently t[illegible] filings will distribute themselves in [illegible] those shown in Fig. 1. These are called [illegible] 'lines of force'. The lines indicate two [illegible]

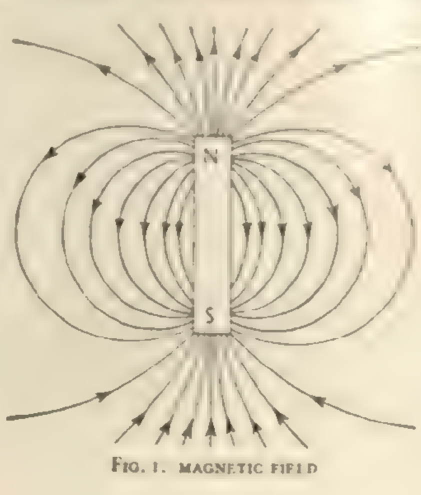
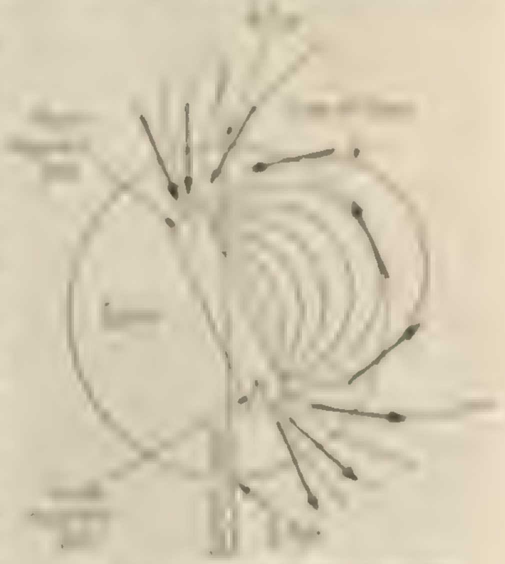


FIG. 1. MAGNETIC FIELD

[illegible] in the field [illegible], along the lines—customarily shown, [illegible] coming out at the magnetic north pole and going in at the south, (b) its intensity is greatest where the lines are closest together. (The field of force can also be mapped by drawing the successive positions of a compass needle moved about in the field.)

If we imagine the world as a perfect sphere with a magnet set in it at a slight angle to the axis, [illegible] we get a rough picture of the [illegible] called the north magnetic pole—though, as we [illegible] really be a south pole. [illegible] will tend to dip towards the ground and be vertical over the magnetic [illegible] the usual method of [illegible] 'magnetic dip' to be [illegible] and magnetic poles are [illegible] point of the globe, a compass [illegible] points east or west of true north [illegible] when both sorts of poles are in a line. The difference between true north and [illegible] or true south and magnetic south is called the 'magnetic declination', and [illegible] year to year. In 16[illegible], as observed [illegible] it was about [illegible]° east of true north, whereas by 1948 it was roughly 9[illegible]° west. [illegible] approaching true north again by [illegible] a year. In addition to this [illegible], there are very much smaller daily and monthly variations, both thought to be [illegible] by electric currents in the electrified [illegible] of the upper atmosphere. There are also [illegible] associated with sun-spot [illegible] (see SUN), called magnetic storms. These are [illegible] accompanied by the appearance of [illegible] (see ELECTRICITY IN NATURE). All these variations, together with the irregularity of the chief magnetic field itself, show that the Earth's magnetism is due to causes far from simple.

The Sun is also a magnet, and its magnetic field has been measured by means of the spectroscope, because magnetism slightly alters the spectrum of atoms (see COLOUR). In 1946 it was first found possible to measure the magnetic field of a star whose speed of rotation was already known. It was then discovered that the strength of magnetism of these three bodies—the star, the Sun, and the Earth—compared with their mass and speed of rotation [illegible]



[illegible]

[illegible] the [illegible] has been [illegible] and that the [illegible] that we are on the verge of [illegible] new and important knowledge of the subject.

MAINE, U.S.A., *see* UNITED STATES OF AMERICA.

MAJORCA, *see* BALEARIC ISLANDS.

MALAYA. The Federation of Malaya [illegible] the southern end of the [illegible] jutting south from Burma and Siam to the narrow Malacca Straits on the other side of which is Sumatra in the East Indies (see Map, p. 144). The frontier between Malaya and Siam winds across the peninsula some [illegible] miles north of Singapore, which is at the southern tip, only about [illegible] miles north of the Equator.

Most of Malaya is highland. Some of the hills rise to over 8,000 feet above sea-level, and nearly all are covered with thick forest, as is much of the lower ground too. This thick equatorial

COCO-NUT TREES IN PERAK, MALAYA
Miss E. Gibbes

FOREST (q.v.) is the natural vegetation of Malaya. The trees in it are tall, and there is usually a dense thicket of undergrowth winding and twisting half-way up them, so that movement is very difficult. These forests are the home of jungle elephants, wild buffaloes, tigers, attractive honey-bears, pythons, birds, butterflies, insects that buzz and bite, and weird spiders. Many rivers wind through the lowland forests, but few are large and none is navigable except by native canoes. They usually reach the sea through mangrove swamps, in and out of which the tide washes, covering and uncovering the high roots of the mangrove-trees (*see* picture, p. 98). Where there are beaches they are very lovely, with yellow sands backed by palm-trees. In the coastal waters there are sharks, and crocodiles live in the rivers.

Temperature is round 80° F. by day and night throughout the year. Sun, enormous clouds, a terrific thunder-storm, sun again—such is the weather. Rainfall is just under 100 inches per year. Day and night are almost the same length and there is no twilight.

The soil of Malaya is rich and red, and very fertile: almost a quarter of the land has been cleared of the thick forest. Down the west coast there is a band of rubber plantations with trees in long straight rows. There are coco-nut plantations in all parts, and, in Johore state especially, there are large pine-apple plantations. In the flatter areas there are vast expanses of paddy-fields, rice being the main food of the people.

Malaya now produces more than a third of the world's tin. The gravel containing the tin is dredged up by floating dredgers, and when the ore has been separated out by washing, the remainder is deposited as thick mud. The workings, which used to be in the hands of the Chinese, are chiefly in the districts of Perak and Selangor in west Malaya.

SINGAPORE (q.v.), the business centre of the country and an important naval base, is much the largest town. Georgetown, on the island of Penang, off the west coast, is the centre of the rubber trade. Government headquarters are at Kuala Lumpur. Roads and railways have been furthest developed in the western coastal strip, and are now being extended into central and eastern Malaya. But there are regions where the routes are still mere forest tracks.

See also Vol. I: MALAYA, PEOPLES OF.

MALDIVE ISLANDS, *see* INDIAN OCEAN ISLANDS.

MALTA. The Maltese group consists of three islands, Malta, Gozo, and Comino, and the islets Cominotto and Filfla. Malta, the biggest of the group, is about two-thirds the size of the Isle of Wight, 95 square miles. Gozo is 20 square miles, and Comino smaller still. The total population of the islands is about 315,000. The group lies in a strategic position in the Mediterranean, south from Sicily (*see* Map, p. 160).

The history of the Maltese islands is very old and full of variety. At Hypogeum the remains of the Stone Age—a huge series of connecting galleries and chambers hewed out of the subterranean rock—are some of the largest known. Phoenicians, Greeks, Carthaginians, Romans, Arabs—all have left their mark in Malta. Then for about 230 years the island was the headquarters of the Knights of St. John of Jerusalem (*see* KNIGHTS, ORDERS OF, Vol. I). They built Valletta, the fortified harbour and capital, as well as good roads, watch-towers, and aqueducts. In 1814 Malta became part of the British Empire.

In the north and east the coast of Malta is indented with deep bays; on the west and south the cliffs in places rise sheer from the sea to a height of 300 to 400 feet. The country is hilly and barren in appearance, with few trees and no rivers or streams. Instead of hedges there are stone walls; in place of trees is the dark evergreen foliage of the leguminous carob shrubs and the grey-green of the prickly pear. The effect of the brown and yellow land, the blue sea, and occasional patches of green, is very beautiful.

BIRZEBBUGA, A VILLAGE ON THE SOUTH COAST OF MALTA. *R. Gardner*

The soil, though thin in places, is fertile, and the country is intensively cultivated. The fields are much terraced to catch all the rain that falls. Early potatoes are grown, and enough corn to supply about one-third of the islands' requirements. In ancient days Malta was famous for its cotton, and some is still grown for local needs. A red-flowering clover is a useful crop, and there are orange groves and plenty of figs. Gozo, in particular, produces much honey—indeed, the name Malta (Melita) probably came from a Greek word, *melē*, meaning honey. Lovely flowers are grown (Cicero mentioned the roses of Malta), and there are fine gardens hidden behind high stone walls. As the summer climate is almost tropical and the winters never really cold, sub-tropical plants flourish. The islands suffer from severe winds: the strong SIROCCO (q.v.) blows from the south, and in November and in February a very fierce north-east wind, the gregale, often does much damage.

The oldest town in Malta is Citta Vecchia (Old City), often called Notabile, situated on a hill in the centre of the island. This was an important and wealthy town in Roman times, and was the capital until Jean de la Vallette, Grand Master of the Knights of St. John, built Valletta in the 16th century. Valletta stands on a ridge of rock which runs like a tongue into the bay, dividing it into two great harbours. In gratitude to the Knights for their successful resistance to the attacks of the Turks, Christian countries contributed large sums of money for the building of Valletta. Great lines of walls and forts were constructed in and round the town and harbour to make it impregnable. It is a magnificent harbour and is now one of the main stations of the British Mediterranean fleet.

The houses in Malta are built of stone and have flat roofs, and windows often leading on to covered wooden balconies. The streets also are generally paved with stone.

See also Vol. I: MALTESE.

MAMMOTH, *see* PREHISTORIC ANIMALS.

MANCHESTER. The Romans founded Manchester (Mancunium, as they called it) beside the Irwell, a tributary of the Mersey, on the dry land at the foot of the Pennines. It became a

small market town, dealing mainly in wool and woollen cloth from the area around. Later it imported wool from Ireland, and by 1600 it was described as the 'fairest, best builded, quikkest and most popular town of Lancastershire'. Except for the Cathedral and its College, both of stone, the buildings were of oak, half-timber, and roofed with stone slates.

In 1641 cotton was imported for the first time, and during the 18th and 19th centuries Manchester developed rapidly as the centre of the cotton industry. To-day most of the spinning, weaving, dyeing, bleaching, and finishing of cotton are done in neighbouring towns, such as Bolton, Blackburn, Burnley, Oldham, and Ashton; and Manchester, with its vast warehouses, is the cotton market and business centre of the cotton trade. The city has industrial areas, but they are engaged mainly in the manufacture of rubber goods, clothing, and paper, and in printing and electrical and general engineering. Manchester has now a population of about 700,000.

In the late 19th century the city was rich and ambitious enough to desire to become a seaport, instead of depending on Liverpool. This resulted in the construction of the MANCHESTER SHIP CANAL (q.v. Vol. IV) which leads to the Mersey. It was opened in 1894. Though LIVERPOOL (q.v.), on the estuary of the Mersey, handles the bulk of the cotton cargoes, large quantities come direct to Manchester, as do cargoes of many other kinds.

Manchester, like many other cities which grew up rapidly and without planning in the 18th and 19th centuries, has very congested and ugly districts; but much has already been done to clear slums, and the proposed plans for the future lay emphasis on wide streets and an ample allowance of open space and public parks. Although essentially an industrial city, Manchester has a strong cultural life, stimulated by its university. The Manchester Repertory Theatre has a great reputation, as has also the famous Hallé Orchestra, once housed in the Free Trade Hall, which was destroyed in the Second World War.

MANCHURIA (Manchukuo) lies at the head of the Yellow Sea, on the north-east of China (*see* Map, p. 87). Until 1931 Manchuria was part of China. In that year Japan began a series of military operations against China. As a result, in 1934 Manchuria was declared an

A VILLAGE IN MANCHURIA
The houses are built of plaster and surrounded by mud walls. *Mondiale.*

independent state, officially under its own emperor but actually under the domination of Japan. In 1945, after the Second World War, it was returned to China.

North-western Manchuria is taken up by the Great Khin-gan Mountains. These are high and rugged, and large areas are forested with pine, fir, spruce, oak, walnut, and birch. In the north the Little Khin-gan Mountains run south of the valley of the Amur River, which makes the boundary with the U.S.S.R. In eastern Manchuria, high, heavily forested mountains extend southwards and jut into the Yellow Sea as the long peninsula of Liao-tung. It is for the most part volcanic country, with old crater lakes set in beautiful woodland, although many of the woods have been felled. The highest peak, Paikto Shan, is an extinct volcano, and its magnificent crater lake, some 7,000 feet above sea-level, is known to the Chinese as the 'Dragon Pit' and regarded as the mother of all the other lakes. It was the sacred mountain of the Manchu Dynasty, the dynasty which conquered China in 1662.

The rest of Manchuria is rolling plain of immense fertility, except for a sandy semi-desert area in the west, known as the Eastern Gobi Desert. Soya-beans are the main crop and chief export, but wheat, maize, millet, beet, and flax are all cultivated. There are considerable coal-mines, as well as iron, silver, lead, and copper-mines, and it seems likely that there are rich oil deposits still to be exploited.

Mukden was the old capital of the Manchu Emperors before they conquered China and moved to Peking. It is an important railway centre, and looks much like a western city with its broad streets and high concrete buildings. Changchun, the administrative capital, is a much smaller city, full of government buildings and barracks. Dairen, the principal port, is near the tip of the Liao-tung peninsula, in the very south of Manchuria.

See also China.
See also Vol. I: Chinese Civilization.

MANDALAY. This is the biggest city of upper Burma, with a population of about 163,000—only about a third of that of Rangoon (q.v.), the capital, in lower Burma. However, Mandalay is much more truly a Burmese city than Rangoon.

The old kings of Burma frequently began their reign by building a new capital, generally in the heart of Burma along the great bend of the Irrawaddy (q.v.). Mandalay was founded there less than a century ago by the last king but one, Mindon Min. The great bend was chosen because it was within easy reach of most parts of Burma, while yet being a long way from enemies. It was assured an ample supply of rice from the irrigated plains nearby.

Mandalay is laid out in square blocks between the Irrawaddy and the pagoda-crowned Mandalay Hill. The country around is dotted with Buddhist pagodas and monasteries (see Buddhism, Vol. I). Fort Dufferin, the palace, is in the centre. It was probably copied from the plans of the magnificent capitals of the Chinese Emperors, and many of the buildings within its red, moated walls were very beautiful, with gilded and lacquered pillars, wonderful teak-wood carving, little summer-houses and bridges. There were few modern buildings in Mandalay, except the government and other offices in the centre, and the schools and hospitals on the outskirts: most of the people lived in wooden or bamboo houses, comfortable enough, but liable to catch fire very easily. When the Japanese bombed Mandalay on Good Friday, 1942, much of the town was burnt down. However, its position as a centre for railways and trade is so good that it is likely to regain its old importance.

See also Burma.

MARBLE, *see* Rocks, Section 4.

MARIANA ISLANDS, *see* Pacific Islands; *see also* Vol. I: Micronesians.

MARL, *see* Clays and Shales.

MARRAKESH, *see* Morocco.

MARS, *see* Planets, Section 5.

MARSEILLES. This is the second city and the chief port of France. It is built on the slopes of the bare limestone hills of Provence, on the east shore of a small bay in the Gulf of Lions. It is linked by canal to the River Rhône, which enters the Gulf some 25 miles to the west through an area of salty marshland.

Marseilles, one of the oldest cities in western Europe, was founded by Greeks about 600 B.C.

MARSEILLES

The church of Notre Dame de la Garde overlooks the old harbour. *Dorien Leigh*

It remained a centre of Greek culture till it was captured by Julius Caesar in 49 B.C. After the fall of the Roman Empire it changed hands several times, was destroyed by the Saracens, and finally became part of France in 1481. In 1792, at the beginning of the French Revolution, a band of its citizens went to Paris and introduced there the *Chant des Marseillais*, which has become the French national anthem.

Marseilles grew rapidly in importance and wealth, as trade developed with French-controlled North Africa and with the East as a result of the opening of the Suez Canal. Liners to India and Australia now call at its big modern docks, and large cargoes of coal, oil seeds, grain, wine, soap, and oil are handled there.

The old harbour, used now only by small steamers, yachts, and fishing-boats, is always full of colour and interest, as many races and types of people trade there. From the inner end of the old harbour, La Canebière, one of the main streets, strikes eastward across Marseilles. The old town lies north of the old harbour. In its steep crooked lanes with their cafés, dingy lodging-houses, and squalid slums, live many of the Italians who form nearly a quarter of the 700,000 inhabitants of the whole city.

South of the old harbour a white limestone rock rises abruptly some 500 feet above the sea. With the church of Notre Dame de la Garde on its crest it is a conspicuous landmark for sailors. Several of the islands in the bay of Marseilles are fortified. On one of them stands the Château d'If, made famous by Dumas's novel *The Count of Monte Cristo*.

See also FRANCE.

MARSH, *see* MOORLAND AND MARSH, Section 2.

MARSHALL ISLANDS, *see* PACIFIC ISLANDS; *see also* Vol. I: MICRONESIANS.

MASS. The mass of a body is defined as the amount of matter in it. But the definition is not a very good one, because the word 'amount' suggests either 'size' or 'weight' to us—and mass

is neither of these things. When we hold in our hand a mass of 10 lb. we have to exert a force upwards equal to its weight, i.e. to the force with which it is attracted towards the earth (*see* GRAVITATION). We could show how much force we have to exert by hanging the mass on a spring-balance—the pointer would move to the 10-lb. mark because the force would stretch the spring so far. But the farther away from the earth such an object is taken, the less is the earth's attraction for it, and so the less it weighs. If we could take a 10-lb. mass (which, of course, at ground-level weighs 10 lb.) up to a height of 1,000 miles and there weigh it on a spring-balance, its weight would be found to be very much less than 10 lb.; its mass, however, would remain unchanged.

In everyday life most people do not have to bother about this distinction between mass and weight. But such men as physicists and astronomers, who may, for instance, be dealing with objects many millions of miles away from the earth, need for their calculations a measurement which does not vary as weight does. Mass is the measurement they take. To find out the mass of a body, use is made of a second property of matter, 'inertia' (as important as gravitation itself), which causes every stationary body to remain stationary and every moving body to keep moving in a straight line at exactly the same speed unless some force is applied to it from outside. Such a force might make it move if it were stationary, or, if it were moving already, might make it move faster or slower or in a different direction (*see* MOTION). The resistance of a body to any such force does not vary according to distance in the way the pull of gravity does, and so this second property of matter, inertia, gives a more reliable scale on which we can measure 'the amount of matter' in a body.

We can see the difference between the two scales of measurement by imagining two croquet balls on a lawn, one made of the usual composition, but the other of cast iron. If we were asked to find which was the heavier, we could do it in either of two ways: we could pick the balls up—when we should find that one was much harder to raise from the ground (in fact about seven times as hard); or we could kick each ball—when we should find that one offered more resistance to our toe than the other. In the first case we should have been judging the difference between the *weights* of the balls; but in the second we should have been estimating (rather roughly, since other considerations come in which need not concern us here) the difference between their *masses* by comparing the inertia of each.

Until recently it was believed that inertia never varied at all, and that mass was therefore a perfectly reliable measurement; but within the last forty years the theory of RELATIVITY (q.v.) has shown that, where immense speeds are concerned, mass does change with the speed—and that in fact if it were possible to move a body at the speed of light (186,000 miles per second), its mass would become infinitely great. Speeds approaching this are actually encountered in dealing with the ATOM (q.v.). No less disturbing to older ideas has been the discovery that mass is merely a different form of ENERGY (q.v. Vol. VIII). This was first stated by EINSTEIN (q.v. Vol. V) and has since been proved by the manufacture of atomic bombs, in the explosion of which there is a loss of matter (possessing mass) and the appearance of an immense amount of energy.

See also MATTER.

MASSACHUSETTS, U.S.A., *see* UNITED STATES OF AMERICA.

MATTER. Matter, the stuff of which the Universe is made, can be defined as anything which has weight (or, more accurately, MASS, q.v.). It may be solid, liquid, or gas, changing from one 'state' to another when sufficient HEAT (q.v.) is added or taken away. The problem as to what matter is really made of has fascinated philosophers of all ages. For example, could one keep on cutting a lump of lead into smaller and yet smaller pieces for ever? In practice, of course, no—but is it a theoretical possibility that, given the right tools, a lump of lead, however small, could always be split yet smaller? If not, why not? And at what point must the process stop? What would then be left that could be subdivided no more? Even to-day these questions cannot be answered completely, although modern scientific methods and modern instruments have led us a long way towards a solution.

One of the earliest Greek thinkers, Thales, who lived in the 6th century B.C., believed that all things were derived from water, an idea which he probably got from the Egyptians. In the next century, Empedocles taught that there

were no more than four elements, earth, air, fire, and water, and that all substances were made up of these four in varying proportions. A little later another Greek, Democritus, argued that all matter was composed of small, hard, particles which varied in size and shape and which could be neither destroyed nor subdivided. The way in which these 'atoms', as they were called, arranged themselves was responsible for the difference between substances. When a substance was destroyed, as by fire, for instance, the atoms in it were not destroyed: they were merely dispersed.

We must remember that in those days scientific research and philosophy were not carried on in the same way as they are now. There was no great amount of scientific theory handed down from earlier generations as there is to-day; precision measuring-instruments had not yet been invented, and for lack of these many of the theories suggested could not be checked by experiment. So the philosopher could usually do no more than sit back in his arm-chair and prove his theories by argument. If some of these 'proofs' now seem to us to be childish, we should not forget the conditions in which they were worked out. As a matter of fact the atomic theory suggested by Democritus was extraordinarily acute, considering the lack of any real experimental evidence to support it. ARISTOTLE (384–322 B.C.) (q.v. Vol. V [illegible] and [illegible]ny later scientists attacked the theory be[illegible] argued that matter was not solid righ[illegible]h. If it was composed of separate ato[illegible]t, they asked, could be in the spaces [illegible] them? On the whole, until the slow g[illegible] of true scientific methods in the late M[illegible] Ages led to a fresh examination of the que[illegible] opinion seems to have decided against an[illegible] theory with its 'void' difficulty, althoug[illegible]rters of it were always to be found.

The Renaissance in western [illegible] was a rebirth of philosophical thought [illegible] than of the arts and literature. It was nat[illegible]erefore, that this argument as to whethe[illegible]ter was continuous or whether it contain[illegible] should be renewed. A most important [illegible] of this period was the rapid developm[illegible] mathematics, which gave the scientist[illegible] powers. To-day the physicist who wou[illegible]dy the structure of matter must be al[illegible] expert mathematician.

It is now known that all matte[illegible]ade up out of 'elements', or basic subs[illegible] which cannot be split by chemical me[illegible]nto any simpler forms, and that each ele[illegible] consists of similar 'atoms'. The following [illegible]ome of the commonest elements: oxygen, [illegible]drogen, and nitrogen; aluminium, magn[illegible], zinc, copper, iron, mercury, and platin[illegible]ulphur,

PERIODIC TABLE

The elements are arranged horizontally in order of increasing atomic weights. Those be[illegible]th each unlike any other element. The atomic number is given before the element, the chemical symbol

2. Helium (He) 4·00	3. Lithium (Li) 6·9	4. Beryllium (Be) 9·0	5. Boron (B) 10·8	6. Carbon (C) 12·00	7. Nitrogen (N) 14·0
10. Neon (Ne) 20·2	11. Sodium (Na) 23·0	12. Magnesium (Mg) 24·3	13. Aluminium (Al) 27·0	14. Silicon (Si) 28·3	15. Phosphorus (P) 31·0
18. Argon (A) 39·9 . .	19. Potassium (K) 39·1 29. Copper (Cu) 63·6	20. Calcium (Ca) 40·1 30. Zinc (Zn) 65·4	21. Scandium (Sc) 45·1 31. Gallium (Ga) 70·1	22. Titanium (Ti) 48·1 32. Germanium (Ge) 72·5	23. Vanadium (V) 51·0 33. Arsenic (As) 75·0
36. Krypton (Kr) 82·9 . .	37. Rubidium (Rb) 85·4 47. Silver (Ag) 107·9	38. Strontium (Sr) 87·6 48. Cadmium (Cd) 112·4	39. Yttrium (Y) 89·3 49. Indium (In) 114·8	40. Zirconium (Zr) 90·6 50. Tin (Sn) 118·7	41. Niobium (Nb) 93·1 51. Antimony (Sb) 121·8
54. Xenon (Xe) 130·2 . .	55. Caesium (Cs) 132·8 79. Gold (Au) 197·2	56. Barium (Ba) 137·4 80. Mercury (Hg) 200·6	RARE EARTHS 81. Thallium (Tl) 204·0	72. Hafnium (Hf) 178·6 82. Lead (Pb) 207·2	73. Tantalum (Ta) 181·5 83. Bismuth (Bi) 209·0
86. Radon (Rn) 222·0	87. Virginium (Vi)	88. Radium (Ra) 226·0	89. Actinium (Ac)	90. Thorium (Th) 232·1	91. Protactinium (Pa)

carbon, arsenic, calcium, and silicon. Elements combine in various ways to form 'chemical compounds', which have very different properties from the elements themselves (*see* CHEMISTRY). In any compound the elements of which it is made are always present in exactly the same proportions. The smallest part of any element or compound that can exist and still remain the original substance is called a 'molecule'. For example, water is a chemical compound of two elements, hydrogen and oxygen, one molecule of water being always made up of two atoms of hydrogen and one of oxygen. If we split one of these molecules up, we are left—not with water, but with the elements hydrogen and oxygen.

The beginning of the modern form of the atomic theory is usually attributed to DALTON (1766–1844) (q.v. Vol. V). By that time a clear-cut distinction between elements and compounds had been made. Early in the 18th century, not more than twenty elements had been isolated and identified, though a very few, including gold, silver, tin, iron, copper, lead, and sulphur, date back to the earliest times; but now the number identified was growing rapidly. Dalton set out to discover what results might be expected to follow if he assumed that substances were composed of atoms; and he then made experiments to see if the expected results did in fact happen. He decided from this that all elements were composed of indivisible atoms, and that for any particular element the atoms were all exactly alike. Next, he set out to compare the weights of the atoms of various elements—but here many of his results were badly wrong because he had not realized the difference between an atom and a molecule.

It was the Italian, Avogadro (1776–1856), who first pointed out that a molecule was truly the smallest piece of a substance which could exist without losing its chemical properties, and that it might consist of several atoms. Once this point was settled it became possible to draw up a Table of the Elements arranged in the order of atomic weights, starting with hydrogen, the lightest. But when this had been done, it led to a most unexpected result. Newlands, in 1864, noticed that in many cases those elements which lay eight places apart in the table had many properties in common. From this, a Russian chemist, Mendeleev, in 1869 stated what is known as the Periodic Law—that 'the properties of the elements are in periodic dependence upon their atomic weights'. He and a German, Meyer, then went on to work out a complete table with places for ninety-two elements, ending with uranium. Some of these had not then been discovered; but by means of his law, Mendeleev was able to foretell with great

OF ELEMENTS

other have similar properties. Hydrogen (Atomic No. 1, Atomic wt. 1·008) is omitted because it is and the atomic weight beneath it.

8. Oxygen (O) 16·00	9. Fluorine (F) 19·00	..	.	..
16. Sulphur (S) 32·0	17. Chlorine (Cl) 35·5	..	..	..
24. Chromium (Cr) 52·0 34. Selenium (Se) 79·2	25. Manganese (Mn) 54·9 35. Bromine (Br) 79·9	26. Iron (Fe) 55·8 ..	27. Cobalt (Co) 59·0 ..	28. Nickel (Ni) 58·7 ..
42. Molybdenum (Mo) 96·0 52. Tellurium (Te) 127·5	43. Technetium (Tc) 53. Iodine (I) 126·9	44. Ruthenium (Ru) 101·7 ..	45. Rhodium (Rh) 102·9 ..	46. Palladium (Pd) 106·7 ..
74. Tungsten (W) 184·0 84. Polonium (Po) 210·0	75. Rhenium (Re) 85. Alabamium (Ab)	76. Osmium (Os) 190·9 ..	77. Iridium (Ir) 193·1 ..	78. Platinum (Pt) 195·2 ..
92. Uranium (U) 238·2	93. Neptunium (Np) 239	94. Plutonium (Pu) 239	95. Americium (Am)	96. Curium (Cm)

success what the unknown elements would be like when they had been found. This knowledge was a great help in the search for them.

So long as it was believed (as it was until 1911) that the atoms of the different elements were really the smallest possible division of matter, each being a distinct and different substance, there seemed no possible explanation of the Periodic Law. However, during the present century it has been discovered that even atoms are made up of a few kinds of very much smaller bodies, such as protons and electrons, called 'elementary particles', and that the atoms of the very different elements are all made up of the same kind of particles (*see* ATOM). Moreover, it has been found that atoms can change their nature by losing some of their elementary particles. Radium atoms give off a stream of particles until they become lead atoms, and particles can be knocked off other atoms by bombarding them with immensely powerful forces, such as COSMIC RAYS (q.v.). Elements take their place in the Periodic table according to the number and arrangement of the particles in their atoms.

It is staggering to realize how greatly ideas about the ultimate nature of our universe have changed during the present century. Until recently, all who agreed with Dalton's atomic theory were convinced that matter was mostly bulk and that the space inside the atom was small in proportion to the rest of it—they believed in a nearly solid atom. But now that it has been found possible to measure the actual sizes of the nuclei and electrons, scientists are amazed to find that atoms consist almost entirely of space, in which these tiny elementary particles move. Illustrating this, it has been pointed out that, if the body of a full-grown man could be reduced to a solid lump of its particles, the spaces inside the atoms all being removed, then the lump would be so small as to be invisible without the aid of a magnifying-glass! The impression of the solidity of matter which our senses receive is due to the incredible speeds with which the electrons move—speeds so high that to our relatively slow perceptions these less than microscopic bodies are everywhere at once. Another well-established theory which has been revolutionized is the law of the conservation of matter. Nineteenth-century scientists declared that matter and energy were two different things, and that neither could ever be destroyed. When, for instance, coal is burned in a fire, the coal does not cease to exist, but is changed in form, becoming instead ashes and carbon dioxide, with exactly the same 'mass' in its second form as it had had in its first. But modern scientists with their very much more exact measuring instruments have been able to show that in fact the mass is not the same—that something has been lost. Einstein, as part of his theory of RELATIVITY (q.v.), has shown that when a chemical change takes place, a very small part of the matter is changed into energy. For instance, some of the coal has changed, not into another form of matter, but into energy in the form of light or heat. By this he has shown that matter and energy are in fact interchangeable (*see* MASS). Something of this sort happens when the nucleus of the atom is split to produce ATOMIC ENERGY (q.v. Vol. VIII). The revolutionary theories of Einstein and other modern scientists make it clear that the 20th century will be recorded in history as the time when a new era in scientific thought began.

See also ATOM; CHEMISTRY.

MAURITIUS, *see* INDIAN OCEAN ISLANDS.

MECCA, *see* ARABIA; *see also* Vol. I: ISLAM.

MEDITERRANEAN SEA. This very nearly inland sea, over 2,000 miles long, separates Europe from Africa. It is divided into two basins, north-west and south-east of Italy and Sicily (*see* Map, p. 160).

The north-western basin, triangular in shape, is surrounded by Spain, France, Italy, and North Africa, and contains the islands of CORSICA and SARDINIA, and the BALEARIC ISLANDS (qq.v.). The Straits of GIBRALTAR (q.v.), guarded by the picturesque Rock, form a narrow entrance, only 8 miles wide, from the Atlantic Ocean. The Mediterranean enclosed by Corsica, Sardinia, Italy, and Sicily is called the Tyrrhenian Sea.

The south-eastern basin, rectangular in shape, is entered from the north-west through the very narrow Straits of Messina between Italy and Sicily, or through the Sicilian channel between Sicily and Cape Bon in Tunisia, an entrance guarded by the island of MALTA (q.v.). Greece and Turkey lie to the north, Syria and Palestine to the east, and Libya and Egypt to the south. From the north-west the Adriatic runs in a long arm between Italy on the one side, and Greece

MONTE CARLO

In the foreground is the entrance to the little port of Monaco, and beyond, the Casino with its twin towers can be seen.

Margot Lubinski

and Yugoslavia on the other. Farther east the Aegean Sea runs northwards between Greece and Turkey, and from thence through the Dardanelles and the Bosporus into the Black Sea (q.v.). To the south-east the Suez Canal (q.v. Vol. IV) leads to the Red Sea and Indian Ocean. The large islands, Crete and Cyprus, the innumerable small islands of the Aegean, the Dodecanese (qq.v.), and the Cyclades group, all lie in the south-east basin.

The Mediterranean was formed by the subsidence of great earth blocks during the Tertiary geological period, perhaps some fifty million years ago. The violent earth movements of this period caused the land surface, formed of brittle rocks, to crack, some parts sinking below sea-level. Corsica, Sardinia, Italy, Sicily, and the numerous islands of the south-eastern basin, are parts of the old land surface which remained above sea-level. These earth movements were accompanied by volcanic activity, which is still to be seen in Vesuvius and Etna (qq.v.).

The Mediterranean is warmer and saltier than the Atlantic Ocean—warmer because the cold, deep water of the ocean cannot enter over the 'sill' at Gibraltar, and saltier because of the high rate of evaporation. Indeed, evaporation is so rapid that the level of the Mediterranean is only maintained by water flowing in from the Atlantic and the Black Sea, as well as from the various rivers that drain into it.

The Mediterranean was an important factor in the rise of civilization in the lands bordering it. The Phoenicians (q.v. Vol. I) were the first people to use the sea as a highway, carrying their surplus produce in ships to other lands, and thus laying the foundations of foreign trade. By exercising sea-power in the Mediterranean, Rome was able to form a single political unit out of the surrounding countries. Great natural routes from the rest of the world became focused on the Mediterranean. One led down the Rhône valley from the north; another from the plain of Hungary across the narrow mountain range to the head of the Adriatic; the Russian plains were connected to the Mediterranean by the Black Sea and the Bosporus. Goods from China and India followed long caravan routes, by way of the Euphrates valley, finally reaching the Mediterranean on the Syrian coast. In medieval times, the trade of the world was handled by such maritime towns as Venice and Genoa (qq.v.).

With the discovery of ocean routes from Europe to the East, the Mediterranean lost the important place it had held in world trade. Some of this importance was regained, however, when the Suez Canal was completed in 1869, allowing ships to sail via the Mediterranean from Europe to India and the East. Instead of being the centre of world trade, the Mediterranean then became an important link in world trade routes —of especial importance to Britain with her Empire in the East. Her outposts, Gibraltar, Malta, and the Suez Canal, became points of strategic importance, where a British naval force, the Mediterranean fleet, was permanently based.

MEERSCHAUM. This is a hydrated silicate of magnesium occurring in lumpy masses in river deposits. The word is German for 'sea-foam', which it resembles in being very light and soft, and white to greyish- or yellowish-white in colour. Large quantities used to be used in Germany and Austria for pipe bowls. Asia Minor is the chief source of meerschaum; but Greece, Morocco, and Spain produce it also.

See also Minerals.

MELANESIA, *see* Pacific Islands; *see also* Vol. I: Melanesians.

MELBOURNE, with a population of about 1,326,000, is the second largest city of Australia, and is the capital of Victoria in the south-east of Australia (*see* Map, p. 41). Until the new capital at Canberra (q.v.) was built, it was the seat of the Commonwealth government, and many important federal departments still have their offices there.

Melbourne, alone of the Australian capitals, owes its foundation entirely to private initiative. There was little settlement in that part of Australia until, in 1835, John Batman, an Australian-born bushman, chose the place where Melbourne stands as 'the site for a village'. In exchange for a quantity of blankets, knives, scissors, tomahawks, and similar goods, he 'bought' 600,000 acres of land from some black chiefs. In 1836 the settlement was officially recognized, and a surveyor sent to lay out the town. To this surveyor Melbourne owes its characteristic plan—a right-angled pattern of very wide, straight streets with tree-lined boulevards, alternating with narrow lanes.

At that time, the English demand for wool was leading to a vast expansion of the flocks of sheep of New South Wales, and to their spreading over

AERIAL VIEW OF THE CENTRE OF MELBOURNE
Australian News and Information Bureau

the newly discovered pastures of Victoria. The population of Melbourne soon exceeded 4,000. The discoveries of gold in 1851 led to an even faster growth, since Melbourne was the port for the richest gold-fields. Huge crowds from all parts of the world camped on their way to 'the diggings' in tents or huts wherever they could find space, and successful gold-miners spent their money recklessly, drinking champagne out of buckets and driving horses shod with gold down the streets. Melbourne rapidly became the largest and richest city in Australia. As gold became harder to find, she developed light industries, such as the manufacture of clothing, shoes, and chemicals, to provide employment for her population; but at the end of the 19th century she was overtaken by SYDNEY (q.v.), capital of New South Wales, which is now the largest city in Australia.

In spite of many modern buildings, huge retail stores and thriving business premises, Melbourne, with its solid, ornate, stone buildings and broad streets, still retains some of the aspect of a city of the 1880's. Its University dates from the gold-field days. The Art Gallery houses the finest collection in Australia.

Melbourne has long been the financial centre of the Commonwealth, and other states owe much of their development to Melbourne companies. Its people are somewhat conservative in outlook, and like to consider themselves more English than those of other parts of Australia—until recently, business men might even be seen in bowler hats! The Melbourne Cup, a horse-race run in the first week in November, is recognized as Australia's greatest sporting event, and brings visitors to Melbourne from every other state.

See also AUSTRALIA.

MERCURY (Metal), *see* METAL ORES; *see also* PRESSURE.

MERCURY (Planet), *see* PLANETS, Section 2.

MERIDIAN, *see* ASTRONOMY, MEASUREMENTS OF, Section 2.

MESOPOTAMIA, *see* IRAQ.

METAL ORES. Most people have a fairly clear idea as to what is a metal and what is not; but it is not possible to give an exact definition of a metal. In general, we think of a metal as an element that: (i) has a shiny look—a 'metallic lustre'—when freshly cut; (ii) is rather hard and heavy; (iii) can be changed in shape by hammering or bending; and (iv) conducts heat and electricity well. But some of the metals do not have all these properties—for instance, aluminium and magnesium are light in weight, while mercury, being a liquid, can hardly be hammered or bent. Most metals will take a high polish; but few of them keep bright for very long. Those which do are called the 'noble metals'; and it was this property which caused the two most important of the group—gold and silver—to be used from very early times in ornaments and, later, in coinage. Platinum and mercury are also among the precious metals. The best known of the 'base metals' are iron, copper, tin, lead, zinc, aluminium, magnesium, and nickel.

Few metals, as they exist in the earth's crust, are in the metallic state: they are generally found chemically combined with other substances—principally with oxygen as 'oxides', with sulphur as 'sulphides', with carbon and oxygen as 'carbonates', or with silicon and oxygen as 'silicates' (*see* CHEMISTRY). These

chemical compounds are themselves almost always mixed up with a larger or smaller proportion of earthy matter, such as sand, gravel, clay, or stone. A mixture of this sort is called an 'ore', provided that it contains the metal in such a form and quantity as to make its extraction worth while. This is by no means always the case. For instance, ordinary garden clay is about one-quarter aluminium—but we do not call it aluminium ore, because the metal is combined in such a way with other elements that it would be far too expensive to extract. The real ore of aluminium is a mineral called 'bauxite', which consists of aluminium oxide, sand, and other impurities. One would not think, to look at any of these chemical compounds, that they contained metals: mostly they are rather dull and earthy in appearance. Rust does not look very like iron; but it is, of course, a chemical compound of iron.

As we might expect, it is chiefly the noble metals which may be found in nature actually in their pure metallic state (because it is from their power to resist chemical changes and stay bright that they get their name): in fact, gold and platinum are almost invariably found as metals, and silver occasionally so. Of the base metals, copper does sometimes occur as nuggets (the Red Indians used to get copper from this source); but the most extraordinary example of a base metal occurring almost pure is that of the iron so often found in meteorites (see METEORS). The manufacture of iron followed long after that of copper and bronze (which is a mixture or 'alloy' of copper and tin), because it is far more difficult to extract from its ore, so we can imagine what a gift from the gods it must have seemed to primitive man that a mass of this marvellous metal should fall out of the sky. The American Museum of Natural History, in New York, has the remains of a meteorite which fell in Greenland and from which the Eskimoes had been cutting pieces for over a century to make into tools and weapons.

A MAP OF THE DISTRIBUTION OF THE CHIEF METALS OF THE WORLD

The most plentiful metal in the earth's crust is aluminium, which makes up more than 8 per cent. of the whole. Next come iron with over 5 per cent. and magnesium with over 2 per cent. The other metals are comparative rarities—there is only one part of copper in 10,000, and one of lead in 50,000. What makes a metal common or rare from the point of view of mankind is not the quantity of it existing in the world, but the ease or difficulty of extracting it from its ore. Although it is so very plentiful in nature, aluminium remained unused until the

present century because no cheap way of extracting it could be found. There is estimated to be about five million pounds' worth of gold in every cubic mile of sea-water—but to extract it would cost about five times that amount. On the other hand, the same volume of sea-water contains nearly six million tons of magnesium (a metal far lighter even than aluminium), and in the Second World War it was found profitable to extract the metal from this source. The DEAD SEA and various dry deposits of SALT (qq.v.) also hold enormous stores of magnesium, chiefly in the form of magnesium chloride.

Ores are found in various states and positions in the earth. They may be in alluvial gravels and sands (*see* ROCKS, Section 3 *b*), as with the gold of Yukon and Alaska; or they may be distributed throughout the substance of igneous ROCKS (q.v. Section 2)—some Cornish tin is found like this. They may occur in regular beds or strata lying between other sedimentary ROCKS (q.v. Section 3), as do the beds of ironstone in the midlands of England; or they may lie in great irregular-shaped masses, like the haematite (iron ore) of north Lancashire. Finally they may be in the form of 'veins', filling the faults or cracks between rocks of quite different types. As to how they got into these situations, little more can be said than that at the immense temperatures and pressures existing at the formation of igneous and metamorphic rocks it seems probable that metals would be vaporized. In that state they might be driven along through cracks or even through the very substances of neighbouring rocks, to become ores on cooling down. In other cases, metals generally considered to be insoluble have undoubtedly been dissolved in hot water backed up by terrific pressure, and in that state have been forced into veins or throughout rocks.

Metals are distributed over the globe rather irregularly. The map gives some idea of the main sources of the best-known metals—but as it shows sources which are being exploited commercially rather than ore deposits known to exist, it is to that extent misleading. Many parts of the world have not yet been prospected for metals, and in many others, where rich ores are known to exist, difficulty of access or transport has so far prevented development. The chart gives the name of the mineral (or chemical compound) contained in the ores most usually worked for the various metals. Descriptions of the smelting and other processes by which these are extracted and refined for commercial and industrial purposes are given in Vol. VII; some account of their uses in engineering will be found in Vol. VIII.

Metals and their Ores

Metal	*Main Source*	*Chemical Compound in Ore*
Aluminium	Bauxite	Hydrated aluminium oxide
Copper	Copper pyrites	Copper-iron sulphide
Iron	Haematite	Iron oxide
Lead	Galena	Lead sulphide
Magnesium	Magnesite	Magnesium carbonate
	Dolomite	Magnesium calcium carbonate
Mercury	Cinnabar	Mercury sulphide
Nickel	Pentlandite	Nickel-iron sulphide
Silver	Argentite	Silver sulphide
Tin	Cassiterite	Tin oxide
Zinc	Zinc blende	Zinc sulphide
	Calamine	Zinc carbonate

(Gold and platinum, being found as pure metals, are not shown in this table.)

See also MINERALS.

METEORS. **1.** We are apt to think of the tracts of space lying beyond the Earth's atmosphere as empty, except for the large heavenly bodies such as stars and planets. The truth is, however, that space contains a vast number of smaller bodies, ranging in size from specks of dust to very large masses, whose existence is revealed to us only if their paths happen to take them through our own atmosphere—when they are called meteors. We can divide these into three classes: 'shooting-stars', 'meteorites', and 'fireballs'. On almost any clear night, about ten of the first type can be seen every hour, and there are times when the number rises to hundreds. It has been estimated that about twenty-four million meteors reach the atmosphere each day. Fortunately for us, almost all of these are exploded into dust or even vaporized before they can reach the ground as meteorites. It seems, then, that our atmosphere serves as a shield protecting us from a deadly rain of meteors, which it converts to harmless dust.

In early times shooting-stars were regarded as omens, and the falling of stones from the sky as the result of divine action. The *Kaabah*, the sacred black stone of the Moslems at Mecca (*see* ISLAM, Vol. I), is probably a meteorite, and

others are known to have been specially venerated. At Wabar, in Arabia, on the site of an ancient town reputed to have been destroyed by fire from heaven as a punishment for the king's wickedness, there are two meteorite craters, one 100 yards across, which show to this day what kind of disaster befell. It was not until the end of the 18th century that men of scientific mind began to study these matters seriously. The subject is not an easy one, because shooting-stars give no warning of their appearance and can usually be watched for only a second or so.

There are certain known dates in any year when meteors are to be seen in unusual numbers. Measurement of their tracks at any such time shows that they radiate from one particular point in the background of stars. Furthermore, at fixed intervals of years a particularly brilliant display occurs. From these facts it has been found that groups of meteors travel round the sun on fixed paths which (in the case of meteors seen by us) pass through the Earth's own orbit. This path was first calculated for a group known as the 'Leonids' (because their 'radiant' or point of radiation lies in the constellation Leo) which are seen each year on 13 and 14 November. Unlike the orbits of the planets, which are almost circular, the paths followed by meteors are very long ellipses. As we see them each year at the time when the Earth reaches that part of its orbit that crosses their track, it follows that the meteors must be scattered all the way round it; and since the Leonids are particularly plentiful once every thirty-three years, this must be the time taken by them to complete one circuit. The radiants and orbits of many groups of meteors were calculated, and it was then discovered that in a number of cases these agreed with the known orbits of certain comets. Moreover, when one comet failed to reappear at the time calculated, its place was taken by a shower of meteors. It is believed, then, that the head of a comet ordinarily consists of a cluster of meteors, and that, in time, the gravitational pulls of the Sun and planets gradually spread these out round the orbit.

2. Meteorites. Those meteors which reach the ground as meteorites are found to consist chiefly either of iron and nickel, of stony matter, or of a mixture of all these things. They contain no element unknown to us, and no trace of any living matter. Sometimes microscopic diamonds are found in them.

Shooting-stars enter our atmosphere at speeds varying from 65,000 to nearly 300,000 miles an hour. When they get to within approximately 100 miles of the ground, the air in front of them is compressed so rapidly that they become white-hot on the outside. Almost always they are reduced to dust or gases while still more than 20 miles up; but a small number reach the ground. Of these the majority are so slowed up by the air that they hit with no greater force than a falling stone, and so cooled that they can be touched. Very large ones, however, still maintain a prodigious speed: the heat generated by their impact often fuses sand into glass, and, in the case of one which fell in Siberia in 1908, the wind caused by its passage, or by the explosion when it struck, felled forests for almost 40 miles round. The Australian Aborigines evidently still preserve the tradition of a similar catastrophe by calling an even larger group of meteorite craters (one more than 200 yards across) 'Sun Walk Fire Devil Rock'—and by refusing to go anywhere near them. It has been estimated that to make the gigantic Meteor Crater in Arizona, a meteorite at least 500 feet in diameter, weighing more than 1,000,000 tons, must have crashed into the desert. Borings have discovered a very hard object, which may be the meteorite itself, at a depth of 1,376 feet underground. This crater is three-quarters of a mile across and over 500 feet deep. But the largest crater of the kind known is now filled by Lake Bosumtwi, in the Gold Coast of West Africa. This is no less than 6½ miles across and 1,150 feet deep. Imagination cannot picture the destruction that must have accompanied its birth.

Luckily, meteorites fall only rarely: in Great Britain perhaps a dozen are observed in a century, and these are mostly quite small. There is no record of anyone having been hurt, though in 1795 a 56-lb. stone fell within 10 yards of a man ploughing in Yorkshire. Almost always the fall of a meteorite is accompanied by a loud noise, by one or more explosions, and by a trail of smoke.

3. Fireballs. These are meteors which do not, as a rule, end as meteorites, but which are near enough or large enough to be seen, by day or night, as dazzling lights moving at immense speeds across the sky and leaving luminous trails behind them (as do some shooting-stars also). Very often the noise of their passing is heard,

and on occasions they explode with a loud report in mid-air.

See also COMETS.

MEXICO. This republic lies between the United States on the north and British Honduras and Guatemala on the south, stretching from the Pacific Ocean to the Gulf of Mexico and the Caribbean Sea, and separated from the United States by the Rio Grande River. It belongs to what we call 'Latin America'—called 'Latin' because it was first explored from Europe by the Spaniards under CORTEZ (q.v. Vol. V), and Spanish is one of the European languages derived from Latin. The Americans use the phrase 'south of the Rio Grande' to mean Latin America as a whole. Most of Mexico lies in North America; but the part east of the narrow isthmus of Tehuantepec is in Central America. The coast-lines are fairly regular and, consequently, there are few natural harbours. Two prominent peninsulas lie one on the east and the other on the west. The Yucatan peninsula, the cradle of MAYA CIVILIZATION (q.v. Vol. I), juts out northwards, east of the isthmus of Tehuantepec, towards the peninsula of Florida in the U.S.A., and separates the Gulf of Mexico from the Caribbean. On the north-west the long peninsula of Lower California lies like a splinter pointing southwards, separated from the mainland by the Gulf of California. Mexico is a large country—about eight times the size of Great Britain, with a population of some nineteen millions.

Mexico falls into three main regions—the coastal plains, the mountains, and the high inland plateaux. The coasts are bordered by narrow plains covered by forests. In the south, where there is abundant rain, the forest is rich with mahogany and other hardwood trees. Hemp, rubber, sugar-cane, bananas, and chicle gum (used in the U.S.A. for making chewing-gum) are grown in the forest clearings. Beyond the plains rise mountains, and on their slopes, where the climate is more temperate, oranges, coffee, cacao, and tobacco are grown. The plantations are set amid a wealth of beautiful scenery, gay with shrubs such as the crimson

MEXICO: THE VOLCANO EL PICO ORIZABA (18,314 ft.), ONE OF THE HIGHEST POINTS IN THE NORTH AMERICAN CONTINENT

Hugo Brehme (Mexico City)

bougainvillea, and with wild vine and orchids. The mountain-slopes lead to the third region of Mexico, the plateaux, some 6,000 feet above sea-level, which occupy most of the country. Above them, mighty mountains, many of them active volcanoes, rise to summits over 15,000 feet high. Colima, on the western coast, sends forth a

MEXICO

banner of smoke that can be seen far out on the Pacific, and Orizaba on the east coast is the highest, a beautiful, almost perfect, volcanic cone, covered with perpetual snow. Popocatepetl reaches 17,500 feet. Rainfall becomes less in the north of Mexico, and in the very north and in Lower California there are stretches of deserts covered mainly by many kinds of CACTUS (q.v. Vol. II). The plateaux of the centre and south have fertile cultivated areas, often irrigated, and broad stretches of grassland.

The characteristic plant of central Mexico is a kind of cactus called the maguey. It has a cluster of thick fleshy leaves, bluish-green in colour, which taper upwards into a needle-point, and it is often taller than a man. It is sometimes called the century-plant because it is supposed to blossom only about once in a hundred years. These great plants stretch in seemingly endless rows in plantations across the plateau, and their curving leaves seem to echo the curly brims of the Mexican hats. From the leaves of the maguey a sweet juice is extracted, which is made into *pulque*, the Mexican national drink. Mexico City is surrounded by vast maguey plantations, and the *pulque* trains each morning bring vats of their favourite drink for sale to the town-people. *Pulque* is a most unhealthy alcohol, and the Mexican Government has been trying lately to encourage Mexicans to drink beer instead. But as *pulque* was the drink of the AZTECS (q.v. Vol. I) and, before the Aztecs, of prehistoric Mexico, and as it can be obtained by the poorest peasants, it seems unlikely that it will ever be actually banned.

Mexico is very rich in metals of many different kinds. It was known to the Spaniards for its wealth of silver, and it still produces about one-third of the total silver output of the world. It also produces gold, quicksilver, copper, iron, coal, and many other valuable minerals, as well as opals, emeralds, topazes, and turquoises. In modern times petroleum has also been discovered, and now Mexico ranks fourth among the oil-producing nations, next after the United States, U.S.S.R., and Venezuela.

Nevertheless, in spite of this mineral wealth, Mexico is essentially an agricultural country. More than three-quarters of its people are employed in rural industries. There are local native crafts, such as pottery, tile-making, leather-work, saddle and harness-making, and the making of spurs and sombreros (broad-brimmed felt hats). The majority of Mexicans live on the plateaux, and most of the towns of Mexico are situated near the Tehuantepec isthmus. The capital is Mexico City which lies in one of the most beautiful valleys in the world, with two famous snow-covered volcanic peaks, Popocatepetl and Ixtaccihuatl, standing sentinel over it.

See also CENTRAL AMERICA; PARICUTIN VOLCANO.
See also Vol. I: MEXICAN ANCIENT CIVILIZATION; MEXICANS.

MICA, *see* MINERALS, Section 2.

MICHIGAN, U.S.A., *see* UNITED STATES OF AMERICA.

MICRONESIA, *see* PACIFIC ISLANDS; *see also* Vol. I: MICRONESIANS.

MILAN (MILANO) is Italy's first industrial and commercial city and, like Rome, has a population of about one million. It stands in the fertile Lombard plain of northern Italy just south of the Alps (*see* Map, p. 160). The Simplon and St. Gotthard tunnels link it to the rest of Europe, making it the most important railway centre of Italy, and GENOA (q.v.), to the south, provides a port for overseas traffic. The chief

By courtesy of the Trustees of the British Museum (Nat. Hist.)

PRECIOUS STONES, CRYSTALS, AND ORNAMENTAL STONES

1. The 'Edwardes' Ruby (162 carats). 2. Emerald in Calcite from Columbia. 3. Sapphires in Pegmatite from Russia. 4. The Colenso Diamond (133 carats). 5. Calcite from Cumberland. 6. Quartz from Cornwall. 7. Fluor from Durham. 8. Opal in matrix from Queensland. 9. Agate from Uruguay. 10. Moss-agate. 11. Turquoise from Persia. 12. Section of Tourmaline crystal. 13. Zircon in Syenite from Russia. 14. Jasper from India. 15. Lapis Lazuli

MILAN CATHEDRAL

industry of Milan is heavy machinery, including railway equipment; but lighter machines are also made. Other industries are the spinning and weaving of the raw silk produced locally in the largest silk-growing district of Europe. Power for its factories is generated by hydro-electric plant in the Alps. Milan has a lively and progressive political and intellectual life, and influential newspapers are published there. Strangely enough, although Mussolini founded his Fascist party there in 1919, Milan was a centre of resistance to Fascism and German domination.

There was a city at Milan in Roman times, but hardly any trace of it remains. The importance of the present city dates from the Middle Ages, when Milan was the centre of one of the rich and powerful city states of medieval Italy. Milanese bankers and merchants were famous throughout Europe, and they laid the foundations for centuries of commercial prosperity. During the RENAISSANCE (q.v. Vol. I) the Visconti and Sforza families ruled the city in a period of artistic and cultural splendour, during which many fine churches and palaces were built. It was at this time that the very large and remarkable Gothic cathedral and the huge castle were begun. LEONARDO DA VINCI (q.v. Vol. V) spent many years of his artistic life there, and the remains of his great painting, 'The Last Supper', can still be seen on one of the walls of the refectory of Santa Maria delle Grazie Monastery.

In 1513 Milan was conquered by the French, and later fell under Austrian rule, from which it was liberated in 1859 to become part of the United Kingdom of Italy. Since then the city has grown a great deal, and now has large, well-designed suburbs. As an industrial city and railway centre Milan suffered severely from air attacks in the Second World War. One of the famous buildings to be gutted by fire was the Scala Opera House, the scene of some of the world's finest operatic performances.

See also ITALY.

MILKY WAY, *see* UNIVERSE.

MINERALS. **1.** Every kind of ROCK (q.v.) is made up of one or more definite chemical compounds (*see* CHEMISTRY) known as minerals. There are many thousands of these, of every possible shade of colour, and of very different physical properties. Most minerals are 'crystalline', which means that they are formed of a number of particles, of regular shape, and generally with flat sides, called crystals (*see* Fig. 1 and Colour Plate, opp. p. 288). A mineral which has great beauty, either in its natural form or when cut and polished, and which is hard enough not to deteriorate with use, may be

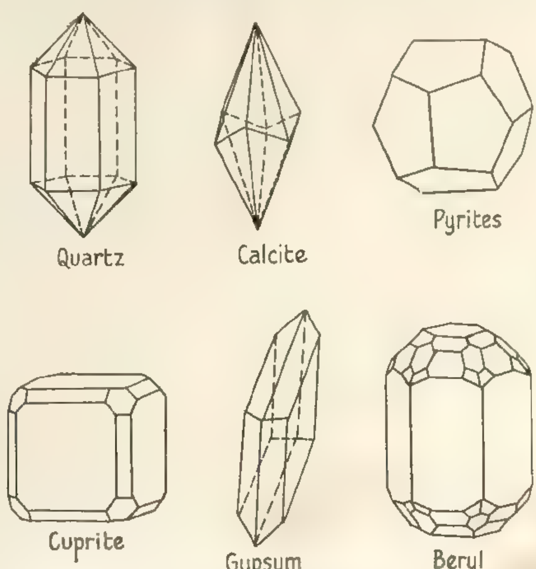


FIG. 1. SOME TYPICAL CRYSTAL SHAPES

valued as a gem-stone if it is sufficiently rare (*see* PRECIOUS STONES).

While the identification of many minerals is the specialized task of a mineralogist, there are some which the amateur can recognize by testing hardness with the thumb-nail and a penknife and by testing colour by the 'streak' made by scratching on porcelain. According to what is known as Mohr's Scale of Hardness minerals can be grouped into 3 classes:

(*a*) Those that scratch glass: these are, in order of hardness, DIAMOND, corundum (*see* SAPPHIRE), TOPAZ (qq.v.), and quartz.

(*b*) Those that can be scratched by a penknife—feldspar, fluor-spar, calcite.

(*c*) Those that can be scratched by the thumb-nail—gypsum and talc.

The thumb-nail and penknife test is particularly useful in distinguishing the three common colourless crystals—quartz, calcite, and gypsum.

2. The principal rock-forming minerals are compounds of metallic elements with silica, which is one of the principal constituents of the earth's crust. Pure silica is found as 'quartz', which is one of the three essential minerals in granite, and also as ROCK-CRYSTAL (q.v.), the purest form of quartz.

An important rock-forming group are the 'feldspars'—crystalline compounds of silicates of aluminium with silicates of potash, soda, or lime. The crystals are not quite so hard as quartz and are usually greyish-white, salmon-pink, or bluish-grey. Feldspar is another of the three essential constituents of granite; and feldspar of some type is, in fact, found in most igneous rocks (i.e. rocks formed from molten material). A form of feldspar which has a pearly lustre like opal is known as 'moonstone', and is classed as a semi-precious gem-stone.

'Mica', the third essential constituent of granite, is the name of a group of silicate minerals which can easily be split into minute flakes having a certain elasticity. All of them have a similar chemical composition, silicates of aluminium combined with potash or magnesium, but they are divided into two groups: the white micas, which contain potash and no iron; and the black micas, containing magnesium and iron. Crystals of mica are easily recognized in granites and in many sandstones, for the tiny flakes give the rock a sheen or sparkle. Mica crystals are soft and can often be scratched by the thumb-nail. Mica of commercial value, i.e. in sheets, is found among very ancient metamorphosed rocks in India and China.

When crystals of black mica include minute particles of radioactive minerals, the radiation causes the rocks to break up. In thin rock sections circles of decomposition can be seen. These are known as 'haloes'. By measuring the extent of these haloes of decomposition it has been found possible to give an approximate age in millions of years to the rock, and this has been of some help in estimating the age of the earth. In black mica, the black crystal containing the radioactive material is usually the mineral ZIRCON (q.v.)—an exceedingly hard mineral, good crystals of which rank as valuable gem-stones.

3. Minerals which contain a smaller proportion of silica than those described, but more iron, calcium, and magnesium, are, because of their composition, both darker and heavier. Three common minerals of this type are 'hornblende', 'augite', and 'olivine'. Hornblende and augite are both black when seen as crystals in a rock; but their sections seen under the microscope may be brown or green, the colours being rather paler in augite. A mineral related to hornblende is 'nephrite', more commonly known as JADE (q.v.). 'Jadeite' is a mineral belonging to the augite family and, like jade, is mainly green. Olivine crystals may be black, yellow, or olive-green, perfect green crystals being sold as gems, under the name of 'peridot'. Olivine breaks up readily, forming 'serpentine', a mineral so named because it is frequently veined and stained with red and yellow iron oxides, the streaks running in serpent-like winding cracks. In some places, as at the Lizard in Cornwall, serpentine makes up the whole rock. It is a beautiful stone, particularly attractive when polished, and very suitable for carving.

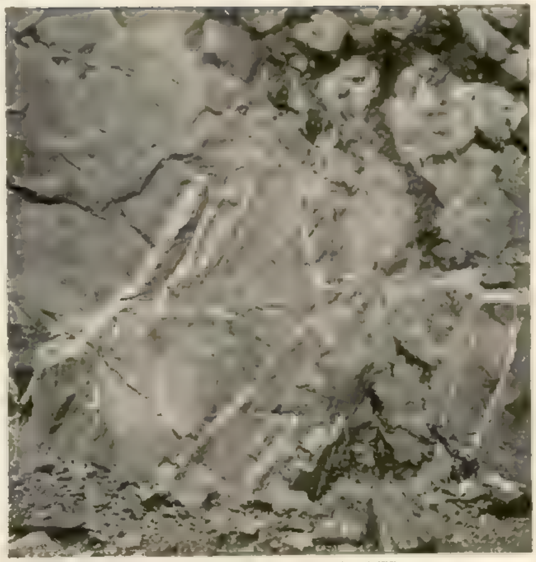
In some parts of the world 'chrysolite' is found (without any antigonite) running in veins traversing the serpentine rock as a mass of fine silky crystals. This is the source of over 90% of the world's commercial ASBESTOS (q.v. Vol. VII). The veins are usually of various shades of green, but are sometimes amber and brown. The crystals are easily separated into fine silky flexible fibres. A far less important mineral, supplying similar asbestos fibres, is the fibrous variety of 'tremolite', a mineral of the hornblende family.

In a few parts of the world, notably in Asia Minor, serpentine rock has been altered into a mixture of minerals, one of which is of peculiar interest, because it is very light and soft. This is the silicate of magnesium which we know as MEERSCHAUM (q.v.), famous for its use in making pipes. Closely related to serpentine is 'talc', with its variety 'steatite' or 'soap-stone'. It is a very soft mineral, pale green, whitish, or colourless. Steatite is used for making the dry lubricant 'french chalk', and is the basis of most cosmetics.

4. The element fluorine is contained in a group of minerals less common than those already described. Fluorine is a highly active gas, capable of attacking and combining with most metals. It can dissolve glass, and is therefore used for etching glass-ware. Fluorine dissolves most silicates, of which glass is one. Minerals containing this element are found mainly in veins which have filled up pre-existing cracks in the rocks, and the gases or liquids containing the fluorine were presumably injected into the cracks from a greater depth in the earth's crust. The commonest of the minerals containing fluorine is 'fluor-spar'. It occurs in beautiful large cubic crystals, often an inch across, coloured by traces of various elements—sometimes yellowish, sometimes green, sometimes white, and sometimes, as in the famous Derbyshire spar or 'Blue John' of Derbyshire, a dark rich blue.

TOURMALINE (q.v.) is a complex silicate containing only a little fluorine and a considerable amount of the element boron. It occurs in star-like bundles of radiating needles in some forms of metamorphic rock, as in Devon and Cornwall. In other cases it occurs as well-developed green, blue, and red crystals, some of which are marketed as gem-stones. TOPAZ (q.v.), which also contains fluorine, occurs in cavities in granitic rocks and sometimes as loose or rolled pebbles. Both topaz and tourmaline become strongly electrified when rubbed.

5. 'Calcite' is important as a rock-former. It is chemically pure calcium carbonate and makes up all LIMESTONES and chalk (q.v.). The sharp-pointed variety, known as 'dog-tooth spar', is usually colourless, but may be stained yellow, red, and brown by impurity, or may be white and opaque. Calcite may also be found in flaky form or as six-sided crystals. In its purest crystal state it is known as 'Iceland Spar', and



VEINS OF QUARTZ IN GRANITE
Ingleton Quarry, Yorkshire. *Crown Copyright Reserved*

is used in polarizing LIGHT (q.v.). All calcite crystals, when broken by tapping, fall into six-sided shapes—a formation that can be followed down to microscopic size. A crystal which fell on the floor of a lecture-room in Paris broke into hundreds of fragments all of the same shape. It was this accident which led a student named Haüy to develop the science of crystallography.

Calcium carbonate may also form crystals of entirely different shape, and is then known as 'aragonite'. It is rather heavier and harder than calcite.

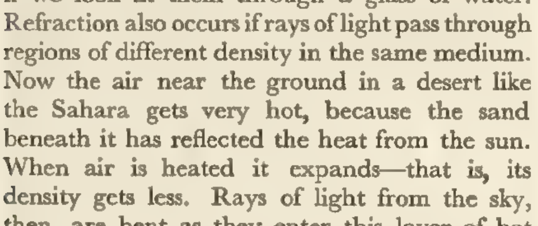
6. The last of the common crystals is 'gypsum', which is sometimes rather like calcite, but is easily detected by its softness, for it can be scratched with the thumb-nail. It is the sulphate of calcium combined with water, and is sometimes known as 'selenite'. It is common both in weathered clays and in some limestones. A fibrous variety of gypsum, having the appearance of satin, is appropriately known as 'satin-spar'; while a compact marble-like form is known as 'alabaster', and is frequently used for carved ornaments and statuary. When gypsum is heated, it loses water and forms 'plaster of Paris'.

MINNESOTA, U.S.A., *see* UNITED STATES OF AMERICA.

MINORCA, *see* BALEARIC ISLANDS.

MIRAGE. There are many stories of travellers who, tortured by thirst in the desert, have been overjoyed to see in the distance a beautiful lake —only to find, as they drew nearer, that it vanished—a mirage. Nearer home, most of us have seen in very hot weather an appearance of pools of water lying across a road which we know well must be dry. This, too, is a mirage. The cause of these queer illusions is a process known as 'refraction'. When rays of light pass from one medium to another of different density, as from air to water or to glass, they are 'refracted' or bent. Thus a straight stick appears bent if obliquely half in and half out of water; or, as we all know, objects appear very distorted if we look at them through a glass of water. Refraction also occurs if rays of light pass through regions of different density in the same medium. Now the air near the ground in a desert like the Sahara gets very hot, because the sand beneath it has reflected the heat from the sun. When air is heated it expands—that is, its density gets less. Rays of light from the sky, then, are bent as they enter this layer of hot thin air, and the traveller sees on the face of the desert (or we on the surface of the road) a brightness which looks like a pool of water but is really the brightness of the sky. As the layer of hot air is rarely still, the image also shimmers in the heat, causing a movement which is easily mistaken for ripples on the water.

But layers of air at different densities can play even stranger tricks than this. Sometimes,



MIRAGE OF A SHIP IN THE POLAR REGIONS

especially in polar regions, it happens that the air immediately above the surface of the sea is very much colder (and so denser) than the air above. In such circumstances sailors may see the image of an object which is really well below the horizon and so out of normal sight. Stranger still, the effect of the layer of warm air above may be to twist the rays of light before they reach the observer, in which case he will see an image of the ship or iceberg upside down in the sky—at the same time as or even before he can see the object itself. It is not uncommon for whalers to get their first sight of a neighbouring ship in this way. This reversal of image also happens at times in the desert, and no doubt the seasoned traveller who sees palm-trees standing on their heads in an oasis does not allow his hopes to rise too high.

On other occasions the air plays the part of a gigantic telescope, and magnifies distant objects, as well as bringing them up over the horizon. In this way the coast of France has been seen in great detail from a town in England lying over 50 miles away.

See also WAVE MOTION, Section 3.

MISSISSIPPI RIVER. This great river figures large in American history and legend, in the folk-lore of the Indians who called it 'The Father of the Waters' and fought a long and losing fight against the white invader on its banks, and in the songs and stories of the negro slaves of later times. The first European to discover it was a Spaniard, Fernando de Soto, in the 16th century. Over a hundred years later the famous French explorer, La Salle, followed its course from Illinois to its mouth and took possession of it for France, naming the territory Louisiana in honour of his king, Louis XIV. Though he knew the value of the land which he claimed, as did the British colonists to the east, later Spaniards and Frenchmen did not; and after being ceded to Spain by France, and then by Spain back to France, it finally became part of the United States of America by purchase in 1803. From then until the outbreak of the Civil War in 1861 and the coming of railroads, the Mississippi dominated the economic life of the South and the Middle-West. It was a period of colour and flamboyancy, of steamboats and showboats—floating theatres which gave performances, mostly of melodramas, at waterfront towns—a period which has been vividly portrayed by Mark Twain in *Tom Sawyer*, *Huckleberry Finn*, and *Life on the Mississippi*. Mark Twain spent his boyhood days at Hannibal, Missouri, where there is a fine monument to him, overlooking his beloved river. After the Civil War the river never regained its former importance as a highway. There are still many steamboats, and even some showboats; but railroads, with their greater speed, certainty, and

THE MISSISSIPPI NEAR LOUISIANA
Laden barges are pushed by a powerful steamboat. *Dorien Leigh*

convenience, have destroyed any hope of a return to the time when trade and intercourse between East and West, North and South, depended upon control of the Mississippi. The present and future importance of the river lies more in the development of its water for irrigation and for hydro-electric schemes.

The Mississippi and its tributaries drain the great central basin of the U.S.A. between the Rocky Mountains and the Appalachians (*see* Map, p. 318); it is said that a stick dropped into any stream or river in the U.S.A. east of the Rockies and north of Oklahoma is likely to be washed past New Orleans! With its tributaries it forms one of the largest inland navigation systems in the world, with an extent of over 12,000 miles. There are three principal branches. The middle one is the Mississippi itself, rising in hilly country to the west of Lake Superior and flowing southwards to the Gulf of Mexico. The western branch is the Missouri, a very turbulent and muddy river, popularly known as 'The Big Muddy', which rises in the Rockies, is itself fed by great tributaries like the Yellowstone, the Platte, and the Kansas, and flows south-east until it joins the Mississippi 17 miles north of the city of St. Louis. The eastern branch is the Ohio, which rises in the Appalachians, flowing south-west through the Pennsylvanian coal-field into the Mississippi at a place called Cairo, south of St. Louis. It too has many tributaries.

Above Cairo the river-lands of the Mississippi are very varied. Below Cairo the whole appearance of the landscape changes. The valley gets wider and flatter until it looks more like a vast plain than a valley, and the river winds in great deep curves, sometimes forming lakes called 'ox-bow' lakes. As it approaches the sea and its delta, it becomes slower and muddier. New Orleans, the Queen City of the Mississippi, is 100 miles from the sea. It was once a lawless river town, a centre for showboats, gamblers, plantation owners, slave traders, and cotton traders, and is still a romantic and important city, with its semi-tropical climate, its French names, its distinctive architecture, its eminence as a cotton port, and the air of gaiety which has not left it, even though the South is not as prosperous as it was before the Civil War. The

[illegible] of the plantation owners are [illegible] of the past, [illegible] poor whites and poor blacks is [illegible]; but the negro still sings his [illegible] songs and his spirituals on the banks of 'Ol' Man River', which to him is still a symbol of [illegible].

The Mississippi can be very [illegible]. All along its course towns and cities depend on it for drinking water, use it in [illegible], in factories, and as a place in which to fish, swim, shoot ducks, and sail their boats and steamers. Farmers rely upon it for irrigation, and the rich alluvial soil which it brings down adds to the fertility of their lands. But this silt is so considerable as to be largely uncontrollable. Many millions of tons of it are carried each year into the sea, and it sometimes fills up irrigation and drainage ditches, kills growing crops, deposits a sort of caky mud which is injurious to plant life, and increases the danger of floods after heavy rains. Besides, the action of the river causes erosion, or the wearing away of topsoil, in some parts, and so damages millions of acres of valuable soil. There were particularly bad floods in 1912, 1927, and 1936, and even in a normal year it is no uncommon sight to see uprooted trees, lumber, sections of fences, pieces of railroad, bridges, barns and outhouses, horses, and cattle being washed down some part of the river. And so its control has become a problem of supreme importance, for there is not enough water in the river and its tributaries to-day to serve the needs of navigation in the lower parts, and yet allow upper-river people all that they want for irrigation. The taming of its waters is being tackled with energy and efficiency. Great reservoirs, such as the Fort Peck Reservoir in Montana, have been built to store and distribute water; channels have been deepened; a fine chain of locks and dams has been constructed between Minneapolis and the junction of the Mississippi and the Missouri; soil erosion has been checked; and the river is being more and more used for the generation of electric power. It is becoming increasingly the servant rather than the master of man.

See also UNITED STATES OF AMERICA.

MISSOURI, U.S.A., *see* UNITED STATES OF AMERICA.

MIST, *see* FOG.

MISTRAL. A cold [illegible] wind which is very prevalent, especially [illegible] the French Mediterranean coast. [illegible] cold heavy air from the central [illegible] flowing down to the area of [illegible] over the warm Gulf of Lions. If a [illegible] pressure over the plateau (by [illegible] and so compressing the air), or if a [illegible] (*see* WEATHER) moves across [illegible] of which events increases the [illegible] pressure still more—the mistral [illegible] with gale force. It is at all times [illegible] and is usually bitingly cold, even th[illegible] brings cloudless skies and bri[illegible]. It occurs all along the coast fr[illegible] frontier to the Gulf of Genoa [illegible] is most common, and reaches its high[illegible] in the districts round Marseilles. Here [illegible] on an average almost every other day.

See also WINDS.

MOLDAVIA. The Moldavian S[illegible] Republic is one of the lesser-kno[illegible] of the U.S.S.R. It is in the south[illegible] Map p. 459); and in the period 1920[illegible] western part, Bessarabia, was part of R[illegible].

Moldavia lies east of the River [illegible] tributary of the Danube, and its [illegible] plateau country is cut by the broad vall[illegible] River Dniester. From the north, into th[illegible] of the country, runs a belt of hills with [illegible] valleys. Cereals, tobacco, and sugar-beet [illegible] on the plateau. Orchards of plums, [illegible] pears, and peaches, walnut groves, a[illegible] vineyards flourish in the valleys. Dairy-farm[illegible] is important, and pigs and poultry are reared.

Industries include wine-making, the canning of fruit and meat, and flour-milling. Kishinev is the capital.

See also U.S.S.R.

MOLECULE, *see* ATOM; MATTER; CHEMISTRY.

MOLUCCAS (Spice Islands), *see* EAST INDIES.

MONACO, *see* FRANCE.

MONGOLIA. This vast, little-known area in the heart of Asia lies south and east of the U.S.S.R., and north of China (*see* Map, p. 87). It is mostly a high, barren, inhospitable plateau, surrounded by mountains, with a climate of

A YAK IN THE MONGOLIAN DESERT

Royal Geographical Society

extreme heat in summer and intense cold in winter. Southwards, the plateau extends into Inner Mongolia, a part of China. Nominally, Mongolia is an independent republic, but it is now very much under the influence of the U.S.S.R.

The only permanent settlements of any size in Mongolia are in the valleys of the mountains to the north. These mountains are wooded with spruce, pine, larch, and birch, and are the home of sable, marten, and marmot, deer, beaver, big-horned wild sheep, and the snow-leopard. Many of the valleys are swampy and studded with lakes; but wherever it is possible the ground is either cultivated or used for grazing.

Southwards, trees get more and more scanty, and pasture thinner and poorer, until the great treeless plateau of the Gobi Desert is reached. Actually it is only in the east that the Gobi drops to low sandy waste. Most of it is high steppe, covered in spring with tall grass which, though thin, is good grazing for camels.

The people are mainly herdsmen, wandering from one grazing-ground to another with their herds of two-humped camels, their horses and sheep, and bartering their produce for other commodities. Trade is in the hands of Chinese merchants, who have established themselves in the few towns and in the villages. The chief town is Urga, or Ulan Bator, in the north-east of the country.

See also Vol. I: Mongols.

MONSOON. We associate this word with India, because there, perhaps more than anywhere else in the world, the monsoon has a very great effect upon the lives of the people. The word comes from an Arabic word meaning 'season', and is appropriate because there are two seasonal monsoons—the summer and the winter monsoon. The summer monsoon is a great inrush of moisture-laden air from the ocean to the land; while in the winter monsoon the winds blow from the land towards the sea (*see* WINDS, Figs. 4 and 5). These winds affect other countries besides India, for northern Australia, China, Burma, Malaya, and even the southern parts of U.S.A. have monsoons.

Let us look at India and see what happens. In India there are three marked seasons: the hot dry season from March to June, the hot wet season from June to November, and the cool dry season from December to March. During the hot dry season the great plains of northern India are heated like a furnace under the influence of the sun, and a region of low pressure develops. By mid-June, pressure is low all the

way to the Equator and beyond, and the south-east Trade Winds, drawn across the Equator towards the low-pressure centre, and being deflected by the earth's rotation (to the right in the northern hemisphere), reach India as the south-west monsoon. Since they have come over the Indian Ocean, they are full of water-vapour. When they meet the hot dry air over India, cyclonic disturbances occur, causing heavy rainfall over the greater part of the country (*see* WEATHER). The onset of the south-west monsoon takes place with great regularity, and can be timed almost to the hour every year. It begins with violent thunder-storms in early June, the rains set in by July, and by November three-quarters of India's rainfall for the year has fallen.

By then the land-mass has cooled and pressure is high over the continent. The wind system is now reversed, and the cool winds of the winter monsoon blow from the land towards the sea. These winds are really the north-east Trades resuming their natural course after the violent interruption, and they bring no rain to India except to the Coromandel Coast and to Ceylon, where the rainfall in late September is heavy, owing to the water-vapour picked up by the north-east winds as they cross the Bay of Bengal.

In some ways the summer or south-east monsoon winds can be regarded as a gigantic sea-breeze extending over a whole season instead of a day. India counts on a successful monsoon, and its many million people, dependent as they are on rice for their food, suffer famine if there is any widespread failure of the monsoon rains.

See also CLIMATE; RAIN.

MONTANA, U.S.A., *see* UNITED STATES OF AMERICA.

MONTENEGRO, *see* YUGOSLAVIA.

MONTEVIDEO. As Magellan's ship in the early 16th century sailed towards the River Plate in South America, the Portuguese look-out man shouted out 'Monte video' (I see a mountain). The mountain he saw was a solitary hill rising behind the flat coast-land of Uruguay. When, later, Uruguay's capital city was built there, it was called 'Montevideo'. The old city was built on a peninsula jutting southwards into the broad estuary of the River Plate. It has now extended inland and westward round the Bay of Montevideo, an almost circular bay protected by breakwaters and dredged to take ocean-going steamers.

MONTEVIDEO, URUGUAY
Loading wool at the docks. *Fox Photos*

As with most South American towns, the streets of both the old and the new town run parallel to each other and are broken by wide squares. Most of the buildings are low—few rise higher than three storeys; but as they are built of stone, the streets have a spacious, dignified appearance.

The main square of Montevideo—the Plaza de la Constituçón—is in the centre of the peninsula. On one side of it stands the Cathedral de la Matriz, with its wide, pillared façade and two towers. To the north of the Plaza de la Constituçón there is another fine square, the Plaza Independença, from which the broad, tree-lined main street of the city, the Avenida 18 de Julio, leads to the new town.

Along the bay and the river-bank are the pleasure resorts of the city. At night the reflection of all the lights in the water and the beams of the lighthouse on the western edge of the Bay give the scene a fairy-like appearance.

Montevideo is not as wealthy a city as BUENOS AIRES (q.v.), on the other side of the estuary. Its inhabitants, of whom there are more than ¾ million, have had to work hard for their prosperity. Their fine university, however, has

trained many graduates who have come to hold important positions in the countries of South America.

See also URUGUAY.

MONTREAL stands on an island in the St. Lawrence River (q.v.), near where it is joined by the Ottawa. It gets its name from a small hill, called by the French colonists Mont Royal, at the foot of which they built a small town, Ville Marie. This little town grew up into the great city of Montreal, the chief city of Canada, although it is not its capital. Few Europeans realize its position as the third largest French-speaking town in the world, only Paris and Brussels exceeding it in size. With over a million inhabitants and some 3,000 factories, it is a great industrial town and a great administrative centre. In it are the headquarters of both the Canadian Pacific and the Canadian National Railroads; and one of its streets, St. James Street, is the financial hub of Canada. Montreal has two universities, an Anglican Cathedral, and a Roman Catholic Cathedral which is an exact replica of St. Peter's in Rome. Like most big European cities it has many fine buildings, squares, bridges (including the famous Victoria Jubilee Bridge), and statues; and, like them too, it has also its poor quarters of noisome slums and back-alleys.

This very modern and very populous city has been built up on the wealth accumulated by the labours of prairie farmers, trappers from the far north, railway workers, lumbermen from the woods of New Brunswick, and fishermen from the west coast. Its activities as a port are considerably handicapped by the annual freezing of the St. Lawrence, as for five months of the year no ships can arrive from Europe or from the Great Lakes (q.v.). But winter has one compensation—Montreal is never more lovely than when its domes, steeples, statues, and trees are covered with snow, glistening and sparkling in the bright sunlight, and giving the city a fairy-like appearance.

See also CANADA.

MOON. If it ever becomes possible to travel through space by rocket-plane, the Moon will be much the nearest stopping-place, because it is only about a quarter of a million miles away; whereas a journey to the planet Venus, our next nearest neighbour in the heavens, would be about twenty-six million miles at least—and the nearest star is so infinitely far away that its distance is too great to be reckoned even in millions of miles and a different scale of measurement is used. It is believed that the Earth and Moon were originally one rotating fluid globe, round which, under the gravitational pull of the Sun, swept a daily tide of molten matter. Eventually the pull became too great, and a huge mass parted, to swing round the Earth as a satellite. This is at least partly confirmed by the fact that the average density of the Moon agrees with the average density of the rocks of the Earth's crust. It has even been suggested that the great deeps of the Pacific Ocean are the gap left by the Moon's departure.

The Moon's mass is less than one-eightieth that of the Earth, and the force of gravity on its surface only one-sixth—so that if men ever succeed in landing there they will have no difficulty in making enormous jumps, and if they fall over a small cliff they will probably be unhurt at the bottom. But they will have to be equipped with artificial breathing apparatus, because the Moon has no atmosphere—its gravitational pull is too small to prevent the swift-moving molecules of a gas from escaping into space.

The Moon has always the same face turned towards the Earth. This is believed to be the result of the tide-raising forces of the Earth, the effect of which has been to slow down the rotation of the Moon, until now it only rotates once during one whole revolution in its orbit. This has now distorted the Moon so that it is very slightly egg-shaped. In fact, owing to peculiarities of the Moon's motion, which show us, at times, a little of the other side, we see in all about three-fifths of its whole surface. All parts of the Moon, however, are lighted in turn by the Sun, and, as it moves round the Earth, we see at different times different fractions of the lighted half. These are called 'phases' (Fig. 1). At new moon the Moon is invisible, because it is then almost in line with the Sun. A few days later it appears, soon after sunset, as a thin crescent, horns pointing away from the Sun, the whole circle being seen dimly illuminated by reflected light from the Earth ('the old moon in the new moon's arms'). Then, rising later every night, it changes through half moon (the shape at 'first quarter') to gibbous ('hunch-backed'), and to full moon, when it is directly opposite the Sun. After full, the Moon

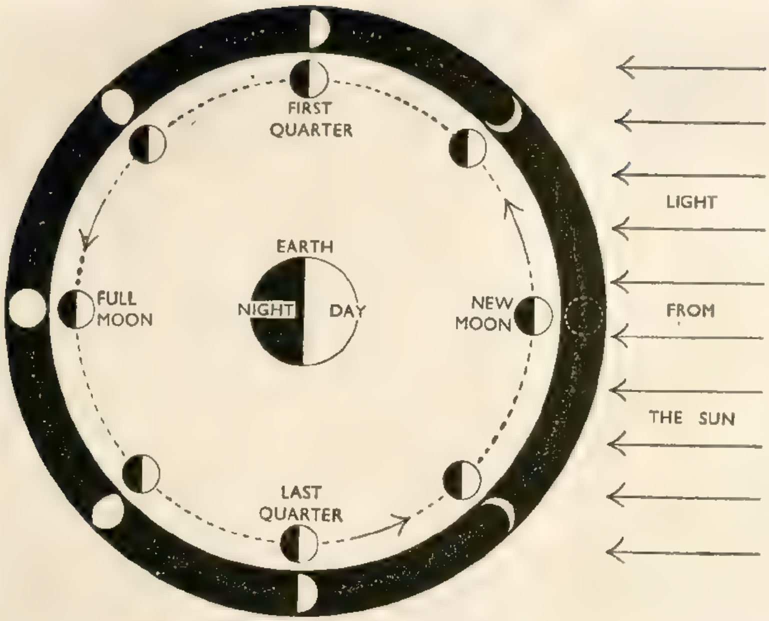


FIG. 1. PHASES OF THE MOON

This diagram explains the changing appearance of the Moon during the lunar month. The appearance of the Moon as we see it from the Earth is shown on the outer black ring

continues to set later and later, and wanes through half (now the 'last quarter') to become a sickle, rising just before the Sun. To go through all its phases the Moon takes 29·53 days—2·21 days longer than it takes to go once round the Earth. The extra time is needed because the Earth itself is moving steadily round the Sun. So the length of a day on the Moon is $\frac{29{\cdot}53}{2}$ of our days, or just over a fortnight.

No other object comes to life so vividly in even a small telescope as this dead world. It is seen as a globe, not as a disk, and mountains are revealed which suggest its size. With the best telescopes, objects as small as 200 yards square can be seen. For an hour or two, sunrise on the mountain-tops may be followed, the peaks catching the light long before their surroundings, and showing as tiny, growing islands of light in the dark area. At full moon, roundness and ruggedness are no longer suggested by light and shadow. Instead, under the vertical illumination, mysterious systems of bright lines, called 'rays', appear, radiating from certain craters. They are from 10 to 20 miles wide and extend over mountains and plains alike, for hundreds and even thousands of miles. Mountains are now indistinct except when they can be seen in profile on the edge of the bright disk, like the milling round a half-crown.

Through the earliest telescopes the surface of the Moon was seen to consist of mountains and darker areas, apparently seas. These were fancifully called by such names as Mare Imbrium and Mare Nubium. Later and better telescopes showed that the 'seas' were not perfectly level and must really be plains. In the lunar southern hemisphere the rings and craters lie overlapping in great confusion. The northern hemisphere shows some splendid mountain-ranges and immense plains walled in by jagged heights. The highest peak in the Moon, Newton, is 24,000 feet high. Such heights can be measured by the lengths of the shadows cast. No one knows for certain how the walled plains and craters and bright rays have been formed. The craters are not very like those of volcanoes on the Earth—but the force of gravity is so much less on the Moon that we should hardly expect them to be. Some people suppose that a great shower of projectiles, perhaps meteorites, struck and damaged the Moon, leaving scars which do indeed look something like bomb-craters, and which also resemble the few meteorite craters found on the Earth. Others think that the craters may have been formed by bubbles of gas rising from the interior of the Moon and bursting on the surface in ages past when this was still only semi-solid.

Even through the highest-powered telescope the appearance of the Moon remains hard and without trace of atmospheric blurring. Minute changes have been reported in its surface from time to time, and these were once supposed to be due to the melting of frosts; but this is now considered to be unlikely, for it has been calculated that during the long lunar day, with no ATMOSPHERE (q.v.) or cloud to mask the Sun's fierce heat, the temperature rises almost to the boiling-point of water, and falls at night as far below freezing-point. It is probably these great extremes of temperature, far exceeding anything

THE FULL MOON

When the Moon is full, long bright rays, radiating from certain craters, become clearly visible. The chief of these craters is Tycho, seen at the bottom of the picture, in the southern hemisphere of the Moon. The brighter parts of the Moon are the mountainous parts; the darker patches are the level plains. It is these patches which look like a face, 'the man in the Moon'. *Ackland Observatory*

experienced on Earth, which cause any changes noticed. The splendid desolation of the scene has inspired writers to give fanciful descriptions of what it would be like to visit the Moon. Seen from the Moon, without any atmospheric interference, the Earth, Sun, and other heavenly bodies would make enthralling sights. The Earth would appear as a great and magnificent object in the sky, oceans and continents clearly visible through breaks in the clouds. It would show phases as the Moon does to us; but it would appear practically fixed in the sky—observers on the Moon's other face would never see it, just as that face is never shown to us.

See also ASTRONOMY, MODERN; ECLIPSE; TIDES; CALENDAR.

MOONSTONE, *see* MINERALS, Section 2.

A SCOTTISH MOOR IN WINTER. *R. M. Adam*

MOORLAND AND MARSH. In practically all countries there are areas where the soil is too thin or poor to support grassland, or where drainage is so bad that for all or part of the year the ground is waterlogged or flooded. Sometimes it is possible to enrich the soil or to drain the ground, and then these areas change from waste-land to farm-land.

1. MOORS are characteristic of upland areas of hard rock and high rainfall. The soil is shallow, and in places has been washed away altogether from the rock. In consequence, in spite of heavy rainfall, the soil dries out quickly, and only plants able to thrive on little moisture or poor rocky soil will grow there. Heather, ferns, gorse, scrub of various kinds, and creeping berry plants, such as bilberries and crowberries, grow on most moors (*see* HEATHS AND MOORLANDS, Vol. II). On many moors hardy breeds of sheep are pastured, while on others, especially in Scotland, deer roam and game-birds such as grouse are bred. In the British Isles there are still large areas of moorland, especially in the west and north. Nearly two-thirds of Scotland and one-third of Wales are moorland, and in England the largest moorland districts are the Yorkshire moors, the Peak District, and Dartmoor and Exmoor.

In most moors, bogs form in hollows and at the foot of slopes in the wet rocky uplands, where drainage is too poor for the moisture coming down from the slopes to escape readily. Bogs are also found in glaciated lowlands in areas of poor boulder-clays. They can often be recognized by the kind of plants that grow on them—green sphagnum moss, deer-grass, and white cotton-grass. The ground is spongy and waterlogged. Sometimes below the surface-crust of mosses and grasses there is a deep swamp of very liquid mud, which soon swallows up any person or animal that sets foot on it. Such bogs may be called quagmires (quaking-bogs). Usually they are crossed by ridges or paths of firm ground, which are often marked by posts to guide the traveller. The WILL-O'-THE-WISP (q.v.) has been accused many times of seeking to lure travellers from these paths. In many bogs there are stretches of compressed brownish-black substance made of partly decayed leaves and roots of bog-plants. Peat-bogs cover altogether one-seventh of the area of Ireland —the Bog of Allen extends for 250,000 acres. The thickness of the peat averages 20 to 30 feet, but sometimes reaches a depth of 50 feet. In Ireland and northern Scotland, as well as in other peat-bog areas—in Wales and Somerset,

A PEAT BOG IN COUNTY DOWN, IRELAND. *G. M. Boumphrey*

for instance—the peat is cut in blocks, stacked to dry, and used as fuel.

The Fens of eastern England—the English counterpart of the coastal areas of Holland—are examples of a different kind of moorland, the low swampy moor. They were originally low-lying peaty bogs interspersed with salty alluvial soil. People used to move about over the water-logged country on stilts. In the early 17th century, drainage was begun, under the guidance of a Dutch engineer, and now most of the district has been reclaimed for agriculture. The ground has been greatly enriched and improved, and is now intensively cultivated with vegetables, fruit, and flowers. Sedgemoor, in Somerset, another example of swampy moor, has also been to some extent reclaimed; but the soil is less naturally rich, and considerable areas still flood almost every winter. Every village has its boats ready for use when the country is under water.

Heathland is found on more sandy soils. Heather and gorse are the most common plants, and in some parts birches and conifers flourish. In the heaths of northern Germany there are many peaty areas.

2. Marsh and Swamp. This is land where drainage is so poor that for all or most of the year the ground is sodden with either fresh or salt water. In some swamps, vast sheets of water are broken only by rushes and reeds, and movement is entirely by flat-bottomed boats or canoes of shallow draught. Willows, reeds, rushes, and clumps of coarse grass are the main vegetation of marsh-land.

Marsh and swamp are found in the deltas of most of the big rivers of the world. Sometimes parts of them have been drained for agriculture, but more often they are wastes and the home of wild fowl. In tropical and equatorial countries, swamps and marshes usually have a dense and luxuriant vegetation. Swamps flooded by salt water have quite different vegetation from those flooded by fresh water. In the salt-water swamps of tropical coasts, such as the west coasts of central Africa and parts of the East Indies, mangroves flourish. All the mangroves have 'stilt' or 'breathing' roots, which rise above the mud and enable the plant to breathe. Their leaves are generally a shining dark green, and the plants sometimes grow as high as 60 feet. Another common tree of tropical salt-water swamp is the nipa palm. Huge fronds, some 20 feet high, rise like giant aspidistras from a stem that creeps along in the mud. In tropical fresh-water swamp, as, for instance, in the valleys of the Congo and the Amazon (qq.v.),

semi-liquid peat often forms under the thick growth of such plants as thorny palms, rushes with sharp edges, sago palms, and wild sugar-cane. There may be little more than a few inches' depth near the swamp edge, but as much as 50 feet in the centre. Sago-palms flourish in very wet conditions. In Borneo and New Guinea the natives cut the palm into short lengths and float or drag them along paths, often completely submerged in water, to their villages.

In Europe, much marshland has been turned into good agricultural land by drainage and fertilization—as, for example, the Pontine Marshes near Rome, the marshes of the Po valley in north Italy, and the marshes of the north German plain.

The *shotts* of southern Tunisia and Algeria are large, shallow, salt lakes which dry out into sandy marshland in the dry season.

MORAINES, *see* Glaciation.

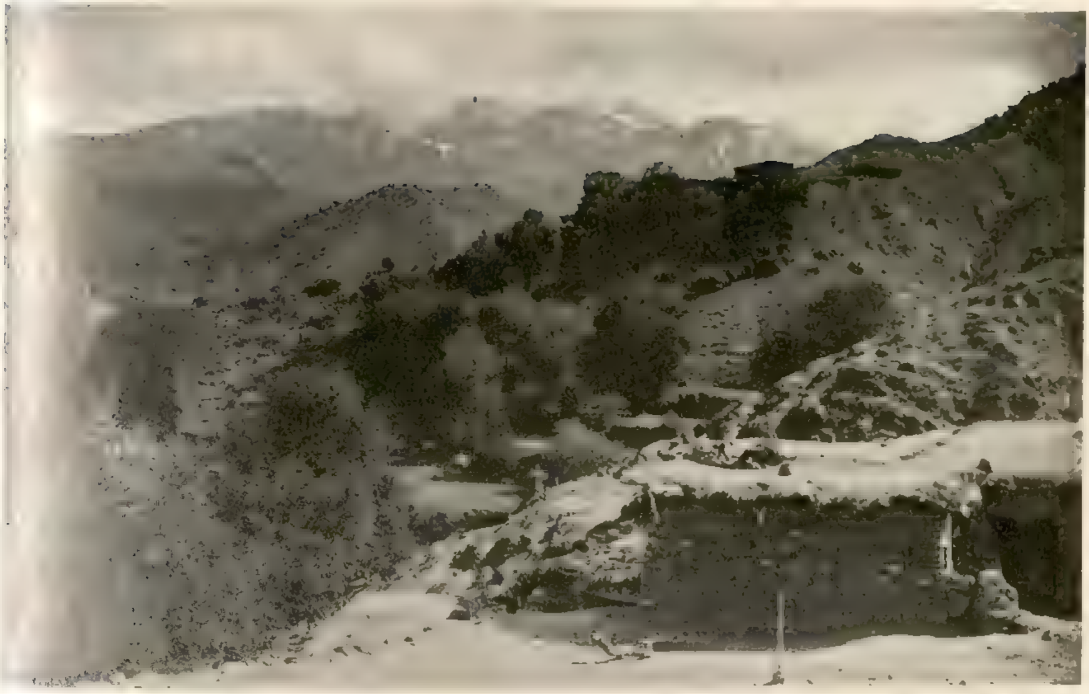
MORAVIA, *see* Czechoslovakia.

MOROCCO. The land of the Moors (q.v. Vol. I) is in the north-west corner of Africa. It has coasts on the Mediterranean and on the Atlantic, and stretches southwards to the edge of the Sahara Desert (q.v.). It is about two and a half times the size of Great Britain. Much the greater part of Morocco is a French protectorate; but the northern tip and a stretch of land about 40 to 50 miles wide along the north coast, with the exception of the small International Zone of Tangier (q.v.), belong to Spain. In the minds of the native Arab peoples of North Africa, however, Morocco is one country, despite its administrative divisions (*see* Map, p. 5).

Spanish Morocco has a narrow coastal lowland, sometimes bordered by sand-dunes planted with scrub and bushes, occasionally wooded by cork-oak or wild pear trees, and sometimes marshy. In places, high cliffs fall to the Mediterranean in almost inaccessible coves and headlands. Inland run the Rif Mountains, rising occasionally as high as 7,000 feet. In the west they are forested with cedar and juniper, with stretches of thorny scrub; in the east they are much more arid and barren. The people live in the valleys, in white-walled villages surrounded by orchards, and grow cereals, vegetables, and tobacco. On market-days they bring in their mixed country produce piled on donkeys, to sell at the nearest town. In the north they keep cattle; farther south they breed sheep, horses, and camels. The country-side of Spanish Morocco, especially in springtime, is rich with flowers—tall blue and yellow Spanish iris, narcissus, mimosa, and purple bougainvillea.

The capital city, Tetuan, has some 80,000 inhabitants. To the west of the high-walled Moorish town the Spaniards have built a modern city, including a university. Much more beautiful than Tetuan is the lovely old walled Moorish town of Xauen (Shawen), with its white-walled houses, narrow twisting streets, picturesque arched doorways and minareted mosques, its grand Kasba (or fortress-palace), and its background of mountains. Xauen lies some 30 miles farther south, and its lively market is the centre for all the nearby Moorish villages.

The outstanding physical feature of French Morocco is the Atlas Mountains, a complex system of mountain ranges, plateaux, and valleys, stretching from the Atlantic coast, through Morocco and Algeria, into Tunisia. The main range, the High or Grand Atlas, runs eastwards from the south-west of Morocco and continues through Algeria as the Saharan Atlas. Its highest peaks rise to over 13,000 feet, and in winter are snow-covered on their northern slopes as low down as 7,000 feet. The northern slopes are in many places well-wooded with red juniper and evergreen oaks; but the southern slopes are, for the most part, dry and bare. From the centre of the High Atlas, the Middle Atlas strike north-eastwards. Among their mountains are many high plateaux cut by deep gorges. Snow frequently covers the land over 3,500 feet high from December to March. On the lower slopes grow junipers and evergreen oaks, and, higher up, cedar forests. The Anti-Atlas strike south-westwards from the centre of the High Atlas to the Atlantic coast. They rise in steep, rugged slopes to between 5,000 and 8,000 feet, with here and there higher ridges. Wherever rivers provide sufficient moisture, villages have sprung up, land is cultivated, and cattle, sheep, and camels are grazed. Some of the rivers vary greatly from season to season in the volume of water they bring down, often breaking out in flood when melted snow or rain-water comes down from the mountains. The greatest expanses of lowland are to the east, between the Rif and Middle Atlas mountains. In the east,



THE ATLAS MOUNTAINS, FRENCH MOROCCO. *Royal Geographical Society*

Fez-Meknes plain, called after the two big es in it, has rich olive-gardens and vineyards. the west, sheep and cattle are grazed.

The capital of French Morocco is Rabat. Its pulation is about 162,000. Fez in the north, larrakesh in the south, and Casablanca in the st are bigger. Fez is a Moorish town, dating m at least as early as A.D. 800. It was a centre Moorish culture: its university, for instance, unded in the 9th century, was a Moorish undation, and the city possesses the largest osque in Morocco. To-day its large native population of some 200,000 makes it an important political and commercial centre of the Moroccan people. It has many local industries, such as leather-work, pottery-making, and carpet-weaving; and its rich and crowded bazaars are filled with perfumes, spices, silks, cottons, jewellery, copper- and brass-work, carpets and leather goods, dates, and sweetmeats. Fez is a crossing-place of two ancient TRADE ROUTES (q.v. Vol. IV)—an east–west route from Algeria to the Atlantic, and a north–south route from Tangier to the Sahara. Besides its Moslem population, Fez has large communities of Europeans and Jews.

Marrakesh, with a population of about 240,000, including considerable numbers of Jews and some 7,000 Europeans, is the largest native city of Morocco. The new European town lies to the west of the old walled town, and round both are vineyards and groves of date-palms, olives, and oranges. Marrakesh also has busy bazaars in which are displayed the native craftsmen's work in leather, jewellery, metal, and pottery. The city has many mosques, the most interesting being the 12th-century Koutoubia, an outstanding example of MOORISH ART (q.v. Vol. XII).

Casablanca has a large number of Europeans among its total population of 570,000. Its very important port is well equipped, and handles large quantities of import and export traffic.

See also ALGERIA; TUNISIA.
See also Vol. I: ARABS; MOORS; ISLAM.

MOSCOW. It has been said that Moscow is more than a capital—it is Russian history itself.

Moscow is first heard of in 1147—when NOVGOROD and KIEV (qq.v.) had already been important city-states for some hundreds of years. At that time it was a typical Russian village, built on the high right bank of the Moscow River, where this was joined by a tributary

THE BOLSHOI OPERA AND BALLET THEATRE, MOSCOW
Soviet Embassy

stream. It became the centre of the increasingly powerful Russian Princes, one of whom succeeded in 1380 in defeating the TARTAR overlords of Russia (q.v. Vol. I). And so Moscow grew in importance. It stood on trade-routes across Russia and became an economic as well as a military centre. It did not, however, become the capital of Russia until 1917.

The Kremlin, the heart of Moscow, stands on the hill-site of the old village. Its 15th-century walls are pinkish in colour, 65 feet high and about 1¼ miles long. Within these mighty walls are palaces and churches, most of them rebuilt in the 15th and 16th centuries and added to decoratively in the 17th century—though the Kremlin Palace was built in the mid-19th century on the site of older palaces of the Tsars. Outside the walls a second town of merchants and traders grew up round the trading-place which is now the Red Square. This, too—the Kitaigorod, as it is called—was eventually walled. Beyond the Kitaigorod, again, there grew up the Byeligorod, the fashionable area of the city, with magnificent roads and boulevards, squares, theatres, hotels, shops, colleges, and schools.

Amid all this beauty, however, there was great squalor and abject poverty. For apart from the splendid boulevards, the greater number of the streets were narrow, twisting lanes, badly cobbled and often unlit, with tall tenements housing thousands of factory workers in indescribably filthy and cramped conditions. Since 1920 much has been done to remedy this: fine blocks of modern workmen's flats have been built, an underground railway has been constructed, tram and bus services have been increased, sewage has been extended, electric lighting in the streets has been initiated, schools, shops, restaurants, theatres have been set up. As a result, although much yet remains to be done, Moscow is to-day a beautiful well-planned city, and a cultural, economic, and industrial centre.

See also R.S.F.S.R.; U.S.S.R.

MOTION. The behaviour of moving objects (and of those at rest) was first fully accounted for by NEWTON (q.v. Vol. V), whose famous Laws of Motion were published in 1687. But the first man to study the subject in a scientific way was GALILEO (q.v. Vol. V), earlier in the same century. He realized that if a body moves or changes its speed or direction, it does so because some force has acted on it; and that if it is motionless, this must be because the forces affecting it balance each other exactly. Newton reduced the subject to an exact science which made it possible for the first time to replace guesswork by accurate calculations.

Newton's First Law, in his own words, states: 'Every body continues in a state of rest or of uniform motion in a straight line, except in so far as it is compelled by some force or forces to change that state.' There are two separate statements in this: that a body will not move unless something moves it, and that a moving body will keep on moving at the same speed and in the same direction for ever, unless something interferes with it.

The first part is clear enough; but the second, obvious though it may seem to many people to-day, was a very brilliant and daring statement at the time when Newton made it. No one had (or has) ever seen anything go in a straight line for ever. In the sky, the moon and planets were known to move in curves; on the earth, if a ball was thrown forwards through the air, its path curved downwards until it reached the ground. We know now that the curve is caused by a combination of the forces of GRAVITATION (q.v.) and air resistance; but in those days these forces were not understood.

To see the truth of the second half of this law, you have only to think what happens if you jump off a moving vehicle. Unless you start to run before your foot touches the ground, you will probably fall on your face. This is because your body will continue to move with the speed and in the direction of the vehicle, whereas your feet will be stopped by friction against the ground. Your body can only cease to move if some force acts on it to slow it up—such as the effort of your muscles. The circus rider who stands on the back of a cantering horse and jumps through a paper hoop has to obey Newton's First Law of Motion. He must jump straight upwards—never forwards—because his body already has the forward motion of the horse, and so his feet will land on the same part of the horse's back which he left.

The First Law of Motion explains what is rather inaccurately called 'centrifugal force', the tendency of a body to fly outwards when forced to rotate in a circle round a central point. From this law it is clear that what the body is actually tending to do is not to fly directly outwards from the centre, but merely to continue in a straight line. If you swing a stone on a string in a circle round your head, and the string breaks, the stone will fly off at a tangent to the circle—that is to say it will continue in a straight line when the force which held it to its circular path is removed.

Newton's Second Law says: 'Change of momentum is proportional to the applied force and takes place in the same straight line in which the force acts.' Stated simply, this means that if a force alters the speed of any object, or starts it moving, the effect is in exact proportion to that force causing it. The word 'momentum' means 'the amount of motion in a body'. This is not simply the speed, but the speed multiplied by the MASS (q.v.).

We can see the point of this law very clearly if we think of what it feels like to stop a hard drive in the cricket-field as compared with catching a tennis-ball moving at the same speed. The cricket-ball is inclined to hurt the hands, whereas the tennis-ball is not. One reason for this is that the cricket-ball is about three times heavier than the tennis-ball, so that its momentum is three times as great, and so three times as much force has to be exerted by our hands to stop it. Similarly, if we were batting, we should have to hit three times as hard at the cricket-ball as at the tennis-ball to drive each at the same speed. By using this Second Law, astronomers, engineers, and others are able to calculate at what speed and in what direction a body will move, if they know its mass and the strength and direction of all the forces acting upon it.

Newton's Third Law says: 'To every action there is an equal and opposite reaction.' This means that when there is one force there is always a second force (or combination of forces) to balance it. If you fire a rifle, the recoil against your shoulder is equal to the force used in giving the bullet its forward speed. When you kick a football, the football kicks back at you just as hard—in fact, if you are running, the force exerted on your foot by the ball may be enough to bring you to a stop. This law is particularly interesting to-day because we can see a striking proof of its truth in aircraft powered by JET PROPULSION (q.v. Vol. VIII). These are driven entirely by the reaction caused by squirting out large quantities of gas at high speed behind them—the gas is forced backward, and the aircraft, consequently, recoils forward.

In the present century scientists have opened up new fields of knowledge in which the Laws of Motion no longer apply exactly: the motions of the tiny particles in the atom do not obey them, nor do those of the heavenly bodies—though the inaccuracy is almost too small to be measured (*see* ATOM *and* RELATIVITY). Nevertheless, it is still safe to say that the general usefulness of Newton's Laws is as great as ever.

MOUNTAIN BUILDING. It is astonishing that fossil remains of animals which must have lived in the sea are often found high up in a mountain range. Only in the last fifty years have geologists fully worked out the explanation —a very much simplified version of which follows.

We believe that the surface 'crust' of the Earth floats on a hot semi-plastic layer of basalt, called the 'sub-crust', that the interior of the Earth is probably very hot, and that, in addition, the crustal rocks themselves are continually accumulating heat as a result of the radioactive minerals which they contain (*see* EARTH). In consequence, there is a rhythm of sub-crustal movement, and in the course of geological history there have been at least nine periods during which great changes have taken place on the Earth's surface,

and huge mountain chains have been formed (*see* EARTH, HISTORY OF, Chart).

There is, in fact, a cycle of changes which repeats itself at intervals of some scores of millions of years. As it is a cycle, we can begin to consider it at any stage we choose. Let us

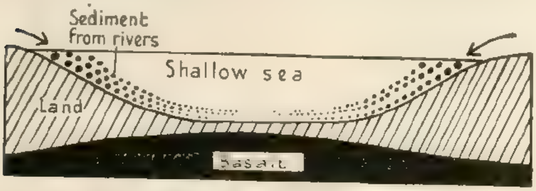


FIG. 1. SEDIMENTS DEPOSITED IN SEA

start from the stage when a great mountain-chain has been formed. We know (*see* DENUDATION) that above the Earth's surface the forces of nature are continually at work, splitting the rocks, tumbling them into valleys, pounding them in rivers and, having finally broken them into stones and small particles, delivering the final material as gravel, sand, and mud into the shallow seas around the continents (*see* Fig. 1).

As the sediments accumulate over periods of millions of years, their weight, being greater than that of water, presses upon the layer of semi-plastic basalt beneath, which, therefore, seeks to move elsewhere. By the same amount as the pressure upon the bed of the shallow sea is increased, the pressure of the land-block upon the basalt beneath it is decreased by the loss of its material. So there is a tendency for the basalt beneath the sediments to be squeezed under the continental margin, causing it to rise. The weight of the sediments alone is, however, insufficient to account for the great extent (sometimes to 40,000 feet) that the sea-bed is depressed, and other factors must also be at work

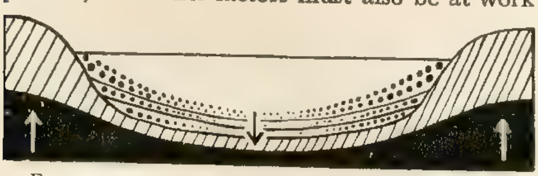


FIG. 2. WEIGHT OF SEDIMENTS PRESSES DOWN BASALT

to explain the great subsidence of the sea-bed which is known to have taken place many times in the Earth's history. No other explanation can account for shallow-water deposits several miles thick. It may be that the accumulating sediments prevent the escape of heat from the layer below and so make the basalt sub-crust more fluid; it may be that convection currents (*see* HEAT) in the Earth's interior play a part; or perhaps the subsidence is merely the persistence of the rhythmic pulse that formed the shallow sea and made the mountain-chain. Whatever the cause, the effect can be depicted as in Fig. 2.

It is clear from Fig. 3 that the bottom layers of sediment shown here are subjected to new forces. Firstly, the beds are being compressed into smaller space as they are squeezed into narrower parts of the trough between two land-blocks. Secondly, they are now much nearer to the hot semi-plastic basalt. Thirdly, they are subjected to very great pressure from above. Fourthly, they will have accumulated from their radioactive minerals a certain amount of heat, which has been unable to escape through the great thickness of sediment above them. It is under conditions such as these that sediments become changed or metamorphosed—sandstones become turned into quartzites, clays into schists, and granitic rocks of the sea-floor into

FIG. 3. SEDIMENTS METAMORPHOSED AND FOLDED

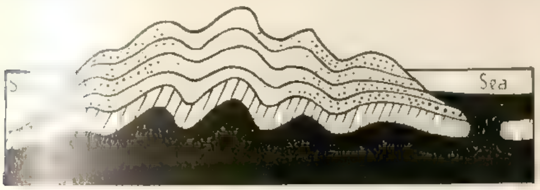
gneisses (*see* ROCKS, Section 4). Indeed, if the structures which we find in the mountain-chains represent, as they probably do in part, the results of sediments being depressed into such a trough, then they certainly undergo drastic treatment. It is no wonder that in some beds all traces of fossils become obliterated, and that it is often impossible to judge even the nature of the sediments from which the rock was formed.

A time comes, however, when this sinking process is reversed. As every period of mountain formation seems to have been associated with great volcanic activity near the region where the mountains appeared, and as vast areas of thousands of square miles are known where lava has poured out in time past to a depth of hundreds of feet, it seems reasonable to suppose that what sets the sinking process into reverse is a great outflow of the sub-crust near the edges of the continental mass, where, indeed, the crustal layers had already worn thin, making the escape of molten basalt easy (Fig. 4). The weight of basalt pouring out now makes the margins of the land-mass heavier—thus the whole process is reversed: the sediments are slowly forced upwards again

4. BASALT BREAKS THROUGH LAND CRUST

between the edges of two slowly sinking landmargins (Fig. 5).

This explanation may be quite wrong—at best it must be an over-simplified statement of what happens; but at least it offers a connected story which enables us to link together definite



5. SEA BED FORCED UP TO FORM NEW MOUNTAINS

stages in the development of mountains. Figs. 4 and 5 show how, by this theory, where sea formerly stood, the folded sediments are raised to form land and mountains, whilst the margins of the former land sink beneath shallow sea. This explains why marine FOSSILS (q.v.) are sometimes found in metamorphosed beds of mountains.

As for the mountain-chains themselves, they often show structures so complicated that it has taken geologists generations to unravel them; but the co-operative efforts of geologists all over the world are slowly solving their puzzles (*see* ROCK FORMATION).

The ALPS and the HIMALAYAS (qq.v.) were parts of the great area of mountains formed in the most recent of the great mountain-building periods in the earth's history—indeed, the uplifting of the Himalayas has not yet been completed. According to one expert, 'the Central Asian Mountains are even now rising by leaps and bounds; and farther south the older Himalayan masses are still being forced over the younger ranges which separate them from the plains of India'.

See also EARTH; EARTH, HISTORY OF; ROCKS; ROCK FORMATION; DENUDATION; EARTHQUAKES; VOLCANOES.

MOZAMBIQUE, *see* EAST AFRICA.

MUNICH (MÜNCHEN). The capital of Bavaria, in the south of Germany, is a city of almost one million inhabitants. It is situated on the River Isar, at the approaches to the Bavarian lakes and Alps. Munich has a history which goes back over 800 years. For many generations it has been the centre of art and science in Germany. It has several famous museums—the Deutsche Museum is Germany's largest science museum, and the old and new Pinakotheks, picture galleries, and the Glyptothek, a gallery of sculpture, all have outstanding collections. It has also theatres and an opera of a high standard. Its old artistic and scientific traditions have attracted visitors and students from all parts of the world to its art schools and university.

The 15th-century Gothic Frauenkirche (Church of Our Lady), with its two tall towers capped by helmet-shaped domes, the old 14th-century Rathaus (town hall), and, opposite to it, the magnificent and richly decorated modern Rathaus with its high tower, and the Renaissance and Baroque palaces, all gave to the town an air of charm and dignity. The modern part of the town is well laid out with spacious, well-proportioned squares, wide avenues, and fine public buildings.

The main growth of the city has been since 1825, and particularly in recent years. Unfortunately, Munich suffered severely from heavy bombing during the Second World War, when its industries of light engineering, book production, art printing, woodwork, china, and pottery were severely smashed, and much, also, of the old town centre was destroyed.

Brewing is a great local industry, and the famous *Bierkeller* (beer cellars) are popular meeting-places for Munich citizens and visitors alike. The town is very gay at the time of the Carnival and the October festival, when everyone forgets work and studies, drinks the famous Munich beer, and joins in the festivities, which last for several days and nights.

See also GERMANY.

N

NANKING. The capital city of modern China was also the capital of Imperial China under some of the reigning dynasties since the time of the Han Dynasty some 2,000 years ago. Under other dynasties, however, PEKING (q.v.) was the capital. Nanking is situated some 200 miles up the YANGTZE (q.v.). It used to be a city of huge dimensions surrounded by walls about 20 miles long, which are now for the most part in ruins. Nanking, however, was razed almost to the ground in the great Taiping Rebellion in the middle of the 19th century, and remained mainly a mass of ruins until it was rebuilt as the centre of the new Republican Government, between 1925 and 1930. When Japan invaded China, the Chinese had to withdraw their capital westward, first to Hankow and then on to Chungking.

The new city spreads over such a wide area that to get from one government office to another may mean travelling for miles along open roads. There is a big riverside suburb, teeming with junks and pontoons. A train-ferry links the two trunk railway lines which run along either bank of the Yangtze. One of the most impressive features of Nanking is the enormous mausoleum built to receive the embalmed remains of Dr. SUN YAT SEN (q.v. Vol. V), 'The Father of the Revolution'.

THE OLD TOWN, NANKING

See also CHINA.

NAPLES (NAPOLI), the largest city in southern Italy, is beautifully situated on a sweeping bay at the foot of the volcano VESUVIUS (q.v.). The neighbourhood has been famous as a holiday resort ever since Roman emperors built their villas round the bay and on the island of Capri. The remains of the neighbouring Roman towns, POMPEII (q.v. Vol. XII) and Herculaneum, buried by an eruption of Vesuvius in A.D. 79, have now been largely uncovered.

Naples was the capital of a kingdom of southern Italy which sometimes included Sicily and, after the 11th century, was generally governed by French or Spanish rulers. In 1860 GARIBALDI (q.v. Vol. V) added Naples and Sicily to the new Kingdom of Italy. During its history, rich and magnificent buildings made Naples impressive; but nothing was done for the poor, who lived in appalling conditions of misery and squalor. In 1884 a cholera epidemic, the last of many, induced the Government to start the improvements which have since made Naples a healthier, if a less picturesque, city.

Naples used to be the largest city in Italy, but now both Rome and Milan are larger. The best known of its many industries is the making of macaroni, although the textile and canning industries actually employ more people. Naples is the chief port of southern Italy, and handles a large quantity of passenger and cargo transport. During the Second World War the port as well as the whole city suffered a good deal of damage. Naples is famous for its music, and offers many facilities for students. It has one of the world's finest opera-houses; while its folk-songs and popular tunes have been made known the world over by such singers as the great Neapolitan tenor Enrico CARUSO (q.v. Vol. V).

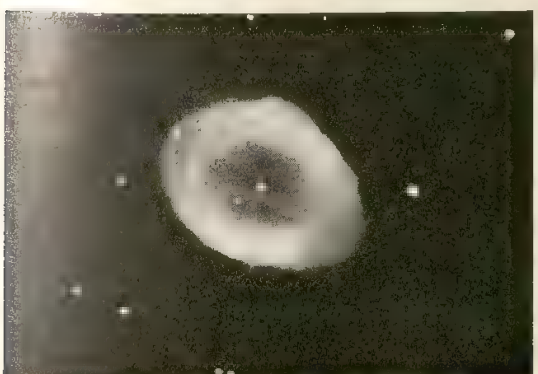
See also ITALY.

NATAL, *see* SOUTH AFRICA.

NEBULAE. **1.** In everyday language the adjective 'nebulous' means cloudy or vague, and to the astronomers nebulae are vague patches of light in the night sky. Since the name was first given to them, more powerful telescopes have shown that many are nothing more than collections of stars—now called 'star clusters'—at immense distances; but examination of the light of others proves them to be vast clouds of glowing gas. Nebulae are of three main types.

2. SPIRAL NEBULAE. It seems that space is dotted with these colossal 'island universes', as they are sometimes called. The Milky Way, that great belt of stars and nebulae which surrounds our solar system and includes the stars of our own CONSTELLATIONS (q.v.) with millions more, may be just one of them. Whether they all contain stars we cannot tell. They lie at such distances that the light from some of them takes millions of years to reach us—travelling, it should be remembered, so fast as to traverse the ninety-three million miles between us and the Sun in eight minutes. Spiral nebulae are themselves moving at speeds of hundreds of miles a second.

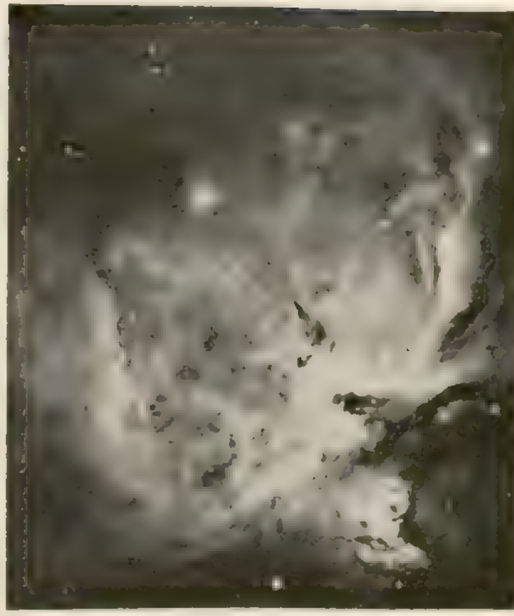
3. PLANETARY NEBULAE. These consist of vast globes of gas, each centred round a very hot star which, it is thought, lends the light by which we see them. In comparison with the spiral nebulae their size is tiny, though many of them are large enough to engulf the whole of our solar system thousands of times over. About



RING NEBULA IN LYRA *Mt. Wilson Observatory*

170 planetary nebulae are known, all of them within our own Milky Way system.

4. DIFFUSE NEBULAE. These are also comparatively near neighbours, being in our own star system. They are of various shapes and



THE GREAT NEBULA IN ORION
Mt. Wilson Observatory

consist of enormous tracts of gas or meteoric dust which are caused to shine by the radiation from stars in them. The Great Nebula in Orion is the best-known example of the many luminous nebulae in or near the Milky Way, and is a very beautiful object in the telescope. There are also 'dark nebulae', patches or lanes of darkness, which give the impression that they blot out the stars behind them. These are believed to be of the same nature as the nebulae just described, but to remain in darkness because they contain no stars to light them.

See also UNIVERSE.

NEPAL. This very mountainous kingdom lies in the eastern part of the HIMALAYAS (q.v.). Mount EVEREST (q.v.), the highest peak in the world, and Kanchenjunga, the third highest, are just within its north-east frontiers. To the north lie the upper Brahmaputra valley and Tibet; to the south there stretches the great plain of the Ganges in India (*see* Map, p. 229).

Nepal, an independent state, is probably best known as the home of the Gurkhas, many of whom enlisted in the British Indian Army, and made excellent soldiers (*see* INDIANS, HILL TRIBES, Section 3, Vol. I). Much of Nepal is still unexplored. European travellers have been discouraged from exploration—indeed, they have

been kept to the road to the capital, Katmandu, where the British Resident (or diplomatic representative) lives.

The river valleys of the south are hot and damp, and in them flourishes a tangle of tropical plants. Higher up, where the climate is cooler, there are terraced rice-fields and crops of cotton, maize, wheat, vegetables, and fruits such as oranges. Still higher, fine forests of evergreen oaks and chestnuts are to be found. Between 8,000 feet and 9,000 feet, rhododendrons flourish, and in April and May the magnificent brilliance of their flowers surpasses imagination. Above 12,000 feet, trees give way to turf and alpine plants, which in their turn give way to rock, ice, and snow.

Katmandu, the capital, with a population of about 90,000, lies at the meeting-place of two rivers. It has many temples, and a huge caravanserai where traders from Tibet and India meet to rest and bargain. The streets are very narrow and wind between rather tall, two or three storeyed houses.

See also INDIA.

NEPTUNE, *see* PLANETS, Section 10.

NETHERLANDS, *see* HOLLAND.

NEUTRON, *see* ATOM.

THE NARROWS LEADING FROM ST. JOHN'S TO THE OPEN SEA, NEWFOUNDLAND
Royal Geographical Society

NEVADA, U.S.A., *see* UNITED STATES OF AMERICA.

NEWFOUNDLAND. This island, almost as large as Great Britain, is separated from the North American continent by the Straits of Belle Isle and of Cabot (*see* Map, p. 318). To many, the word Newfoundland suggests the well-known breed of dogs which were introduced into Great Britain in the 18th century. But the island has many other claims to fame. It is the centre of the world's cod-fishing industry; it occupies a very important position at the entrance to the ST. LAWRENCE River (q.v.); when the first telegraph cable was laid between Great Britain and the United States of America it was laid by way of Newfoundland, which is almost midway between London and New York, the two largest cities in the world; and it was from St. John's, Newfoundland, that the first successful flight was made across the Atlantic.

Newfoundland was the first British colony. It was discovered by John Cabot in 1497, and formally annexed by Sir Humphrey Gilbert in the name of Queen Elizabeth in 1583. The value of its fisheries was soon realized—by Portuguese, French, and Spanish, as well as by British seamen—and there were many violent conflicts on the Banks, as the wide, shelving sand-banks off the island are called. Some of these quarrels developed into international disputes which were not settled until the present century.

The rugged and rocky coast-line of Newfoundland is over 4,000 miles long. It has many beautiful bays, and on the north-west coast the mountains in places come down to the very edge of the sea. There is much swampy and undeveloped land in the interior of the island; but there are also fertile valleys with many prosperous farms, forests yielding valuable wood and pulp, and innumerable lakes, most of which are well stocked with trout. The climate, except in the north, where it is almost Arctic,

is r[illegible] like that of Great Britain. Heavy fogs are common, especially on the south coast but they seldom go far inland.

The population is mainly of British descent, and is less than 300,000. Of these, some [illegible],000 live in St. John's, the capital, a city with two cathedrals, a museum, a fine harbour, and an imposing Government House. There are half a dozen other towns on the island, one with 8,000 and others with less than 5,000 inhabitants each. The main industries at present are fishing for cod in the summer, and for seal in the winter. However, there are large and increasing exports of paper and pulp, and the opening of profitable zinc, copper, and lead mines has revealed new sources of wealth and employment, capable of maintaining a very much bigger population.

Newfoundland, until 1948, enjoyed a partial dominion status of its own; but is now part of the Dominion of Canada. It has one large dependency on the mainland—Labrador, which is nearly three times as large as itself. Labrador is inhabited chiefly by Eskimoes (q.v. Vol. I). It has valuable timber and fisheries, and a great waterfall, Grand Falls, which is higher than Niagara and is certain to be developed as a source of electrical power in the future.

NEW GUINEA, *see* East Indies.

NEW MEXICO, *see* United States of America.

NEW SOUTH WALES, *see* Australia.

NEW YORK. This is the richest and most populous city in the U.S.A. Seven and a half million people live within its boundaries, and Greater New York has three million more inhabitants than has Greater London. Two hundred and fifty years ago its total population was only 33,000. Its astonishing increase has been due mainly to its excellent port facilities, to the good routeways inland, and to the St. Lawrence valley, which made railway, road, and canal communications easy. Less American than most cities of the U.S.A., its cosmopolitan population includes about two million Jews and a very large number of Italians and negroes. However, it is as much the centre of opportunity to the American as London is to the Englishman. It contains Wall Street, one of the great financial centres of the world; it has industries of every kind; it has two magnificent universities, Columbia and New York; its Metropolitan Opera House is world famous; so too are its museums, art galleries, newspapers, and libraries. It is a new city, but none the less striking on that account, and its spectacular skyline of skyscrapers (rising to 102 storeys in the Empire State Building), the Brooklyn Bridge, the George Washington Bridge, and the small island at its harbour mouth on which stands the Statue of Liberty, are world known. New York is governed in five boroughs. The borough of Manhattan Island lies in the Hudson River and is connected to the mainland by subway, bridge, and ferry. It is full of contrasts and

NEW YORK ON A RAINY EVENING

The Empire State Building is on the left, the Rockefeller Center farther to the right, and in the background the Chrysler Building with its needle spire

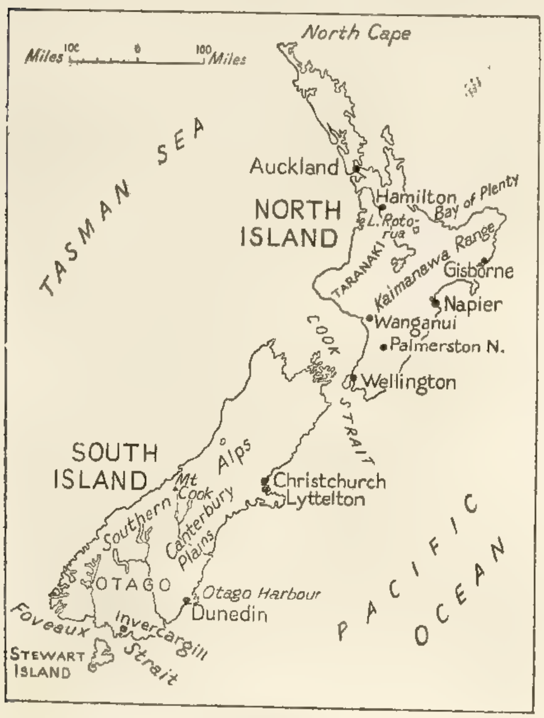
United States Information Service

contains Wall Street and the fashionable Park Avenue as well as the negro quarter of Harlem and the poorer East Side and Bowery districts. Brooklyn, with the United States Navy Yard and Coney Island, the greatest of all amusement parks, makes up another borough. The Bronx, a predominantly Jewish quarter, is a third. The other two are Richmond and Queens.

The city was not always called New York; during the short period of Dutch occupation in the 17th century it was known as New Amsterdam. Captain Nicholls, the naval officer who received the Dutch surrender, renamed it in honour of the Duke of York who was at that time Lord High Admiral of England—and who later became James II. It is long since New York reached the limit of outward expansion. Beyond its suburbs there is marshy land which cannot be built upon. The only alternative is upward expansion—and this has resulted in skyscraper buildings, many of which have as many as eighty or more storeys.

See also UNITED STATES OF AMERICA.

NEW ZEALAND. Many people think that because New Zealand is called the 'Antipodes'



NEW ZEALAND

it is exactly opposite to Great Britain on the other side of the world and therefore must have the same kind of scenery and climate. But this is not so. The north tip of the North Island is roughly the latitude of Madeira, and Stewart Island is roughly the latitude of Lyons in France. New Zealand is therefore much closer to the Equator than Great Britain. This gives it a warmer and more equable climate with mild winters and wet summers. Its area is slightly less than that of Great Britain and Ireland together.

New Zealand is a country of great scenic contrasts. The north peninsula of the North Island has a sub-tropical climate and vegetation, and the coast is broken by many large inlets too shallow to make good harbours. The kauri pine-trees produce good hard timber, and along the coast-line the pohutakawa-tree flourishes with its great crimson flowers. Farther south-west there are steep hills and deep rivers with extremely good agricultural land between—the scene of dairy and fruit farming, including vines, oranges, and lemons. South-west again in Taranaki there is ideal dairying country which on the drier south-east side of the island is used mainly for sheep-grazing.

North and south of the South Island runs the long backbone of the Southern Alps, which fall steeply on the west and south to a coast-line deeply indented with fiords. The New Zealand fiord country on the west coast of Otago, with its steep, forested mountains dropping suddenly to the still depths of clear sea-water, shows some of the most magnificent unspoilt scenery in the world. Farther inland, on the borders of the Otago plain, are long narrow mountain lakes. Higher up in the mountains there are GLACIERS (q.v.), of which the greatest is the Franz Josef Glacier. The mountain peaks are snow-capped all the year round, and the highest, Mt. Cook (called by the Maoris 'Aorangi', the 'Cloud-piercer'), rises to a height of 12,349 feet. The air is so clear that distant mountains stand up sharply against the intensely blue sky. On the east the Southern Alps fall through stony, grey-green foothills to the wide Canterbury plains in the north where the main grain-growing areas are. To the south and in Otago are the great sheep runs. These plains are well watered in the winter and cut up by wide glacial valleys —the beds of roaring winter torrents which in the summer become mere trickles.

PEMBROKE PEAK, MILFORD SOUND, IN THE SOUTHERN ALPS, NEW ZEALAND
High Commissioner for New Zealand

New Zealand is of volcanic origin and has many extinct VOLCANOES (q.v.), especially in the North Island. The last big eruption occurred at Tarawera in 1886. Because of its volcanic structure the country is also unusually subject to EARTHQUAKES (q.v.), and small shocks, which do no harm, are felt fairly frequently. Disastrous earthquakes have occurred, one of the worst being at Napier in 1931. Other evidence of intense subterranean activity is shown in the hot-springs region of Rotorua in the North Island, where there are boiling GEYSERS (q.v.) and hot, plopping mud-pools.

A hundred years ago more than half the country was covered with forests—the New Zealand 'bush'—tall, closely-growing trees, dark green in colour, with a thick undergrowth of huge ferns. The magnificent timber in these forests would have been invaluable to-day had not much of it been recklessly burnt off by the early settlers who wanted land quickly for crops and pasture. The white, ghostly-looking trunks of the burnt bush trees are a characteristic feature of the New Zealand landscape. The Government is now replanting the country with trees such as conifers, eucalyptus, and redwood, to make windbreaks and to prevent soil erosion, but these woods have not the wild natural beauty of the original bush.

There are no native wild animals except birds, and no snakes. There were some wingless birds, such as the moa, whose bones have been

found in large quantities; and there are other species alive to-day, of which the very rare kiwi is the best known. Flight birds were plentiful when settlement began, and there is still a great number. Many European birds and animals have been introduced, including deer and rabbits, which have become pests, destroying crops. There are a few native fish in the rivers; but trout, brought from overseas, have multiplied exceedingly. Big-game fish abound in the coastal waters, which are a paradise for fishermen.

The keynote of New Zealand life is farming. When the settlers first began to export they had to concentrate on a product which would keep well, because of the difficult internal communications and the long sea voyages necessary to market their goods. Wool does not deteriorate with keeping, and so the New Zealanders became sheep-farmers. But when refrigeration was invented it became possible to take up other kinds of farm production. Sheep were bred for meat as well as wool, and large quantities of dairy products were exported. The climate is very favourable for stock-farming because animals can be left out all the year round. The absence of small fields and hedges would be noticeable to an Englishman, what fields there are being divided by wire and split-rail fences. The farmer has to contend with the encroachments of gorse and blackberry.

SHEEP FARMING, NORTH CANTERBURY, NEW ZEALAND

High Commissioner for New Zealand

Internal communications are rather difficult because of the long narrow shape of the islands and the mountain barriers. A spinal column of road and rail runs from Auckland to WELLINGTON (q.v.), the capital, in the North Island, and from Picton to Invercargill, via Christchurch. The two systems are connected by the ferry steamer which runs nightly from Wellington to Lyttelton, the port for Christchurch. Feeder lines from the west and east coasts join the main line all the way down its length. The railway is narrow gauge, and its carriages are small compared with British ones. The locomotives are American-type equipped with headlights. The road system is being developed and the main roads are good. Typical New Zealand 'homes', in the local idiom, are mainly small and compact, made of wood, brightly painted, with corrugated iron or shingle roofs. Wood, the building material most readily available, is suited to the climate and is safer in case of earthquake. Even in the towns, most houses are of wood, only the larger buildings and shops being of concrete, and very few of brick.

The best harbours are found at Auckland and Wellington. Many of the others are continually silting up, and can only be kept open by constant dredging. New Zealand is a very air-minded country, and the Trans-Tasman air route to Australia is much used. Air transport within the country is also highly developed.

See also Vol. I: NEW ZEALANDERS; MAORIS.

NIAGARA FALLS. These mighty falls are one of the great natural wonders of the world although they are not, in fact, nearly the highest in the world—the KAIETEUR FALLS (q.v.), for instance, in British Guiana being five times as high. They are partly in Canada and partly in the United States, as the boundary between the

NIAGARA FALLS

.e American Falls are on the left and the Canadian Horseshoe Falls on the right. *Canadian Pacific Photograph*

countries follows the River Niagara (*see* . p. 318). This flows from Lake Erie into . Ontario, and in its course plunges more . 150 feet over the cliffs of the Niagara Falls. . Falls are in two parts, separated by an island called Goat Island. The Canadian Fall is known as the Horseshoe Fall and is nearly t vice as broad as the American Fall although .o feet lower. It is impossible to describe the grandeur, the fury, and the beauty of the falls. They freeze in winter—and then the ice builds up into queer towers and hanging columns, while the rapids below look like whipped cream.

The falls produce a great amount of electric power. The power station at Queenstown, where most of the power is generated, was the largest in the world until the Americans built the great dams on the Colorado. But, although the falls are of great importance to industry, both Americans and Canadians are alive to the need for preserving their beauty. This is largely dependent upon the volume of falling water, and so the amount which may be used for industry is restricted. Along both sides of the river there are parks, but on the American side factories and small skyscrapers form a rather ugly background.

See also Canada.

NICARAGUA, *see* Central America.

NICKEL, *see* Metal Ores; *see also* Vol. VII: Nickel.

NIGERIA. This is the largest of the British Colonies in Africa, with an area more than three times that of the British Isles. Its coast-line of about 600 miles lies along the northern edge of the Gulf of Guinea in West Africa (*see* Map, p. 5).

Northern Nigeria is part of the Sudan (q.v.). During the dry season, which lasts from October to April, the days are hot and oppressive with dry, dusty winds; the nights are cold. In the wet season, rain comes in heavy showers. Southern Nigeria is part of the Guinea Lands (q.v.). There the dry season ends in March, and the rain comes in long downpours.

Along the coast, and especially in the large delta of the River Niger, there are mangrove

swamps and salt-water swamps. Farther inland, along the lower courses of rivers, there are fresh-water swamp forests from which come several valuable timber trees and fibre plants. But much more valuable are the evergreen forests of the higher and drier land, with their mahogany and ebony trees, rubber trees, and oil palms. Northwards these thin out to woodland and then to the grassland of the Sudan.

Most of the people of Nigeria are farmers, growing maize, yams, millet, and sweet potatoes, and cultivating plantations of cotton, rubber, cocoa, and ground-nuts. Cattle are reared in the north. There are flourishing native industries such as tanning, leather-work, basket and rope making. Tin is worked, and a small amount of gold is produced; but the biggest mineral deposits are coal and lignite. Though many roads have been constructed, some can be used only in the dry season, and rivers are still the main highways. They are used by small steamers as well as by canoes.

Lagos, the capital of Nigeria, is situated on a marshy island in a large lagoon. Bridges connect it to the mainland. Ibadan, the largest

A VILLAGE IN NIGERIA. *B.O.A.C.*

native town in Africa, is bu[illegible] country some 120 miles inland of Lagos. [illegible]ano, in the north, is an important carav[illegible]

See also Vol. I: NEGRO AFRICANS[illegible]

NILE. The early peoples of th[illegible]tern Mediterranean believed that, situate[illegible]ewhere far south of the Mediterranean Se[illegible]re was an Earthly Paradise from which th[illegible]lowed four mighty rivers. These watered t[illegible]hole Earth and were, accordingly, the sour[illegible]ll fruitfulness. To them the most imp[illegible]t of these rivers was the Nile, for on i[illegible]ood-waters depended the prosperity of Eg[illegible] The Nile remained a river of mystery [illegible] the 19th century. In the 1,700 miles of [illegible] course upstream from the sea, it received [illegible] tributary, it crossed a desert region of practic[illegible] no rainfall —and yet it carried vast volum[illegible]of water in regular and heavy floods. Its up[illegible] course was unexplored and its source un[illegible]wn. Little wonder that to the people of Egy[illegible] was sacred (*see* EGYPTIAN CIVILIZATION, [illegible]

In its 4,000 miles of cours[illegible]om Lake Victoria to Alexandria, the Nile [illegible]s through areas of equatorial, tropical, and [illegible]rt climate and vegetation (*see* Map, p. [illegible] From its source in Lake Victoria, in the [illegible]vet forests of UGANDA (q.v.), it descends by [illegible]ipon and Murchison Falls to Lake Albert. [illegible]rom Lake Albert to Khartoum it flows acro[illegible]n alluvial plain: there are many stretches o[illegible]marsh and swamp, and often the river is covere[illegible]by floating islands of vegetation called *sudd*. Sometimes these islands block the entrance of a tributary stream, damming its waters and forming a temporary lake.

At Khartoum, its main tributary, the Blue Nile, joins the Nile. Not very far downstream it is joined by the last of its tributaries, the Atbara. Both the Blue Nile and the Atbara, fed by the heavy summer monsoon rains of Abyssinia, flood down into the Nile in mighty torrents laden with rich silt. So great is the volume and force of the Blue Nile that it dams back the main stream of the Nile—and this dammed-up water comes down as a second flood after that of the Blue Nile. The flood-waters of the Blue Nile and the Atbara reach Aswan in September and Cairo in October.

From Khartoum to Aswan the Nile flows along a narrow valley in a course broken by rapids or cataracts. The country on each side

THE NILE FROM THE AIR

[illegible] picture shows the narrow belt of cultivation along the banks of the river, with barren desert beyond
The Times

is desert, with scattered oases where date-palms and millet are the chief crops, and camels, goats, and sheep are reared.

[illegible] Aswan the valley narrows and is enclosed by high cliffs. The river is crossed by the Aswan dam, [illegible] miles long, which controls the distribution of water to Upper Egypt, holding back [illegible] water to Upper Egypt, holding back sufficient for use in the spring low-water season. Above the dam, irrigation is usually by shallow canals which lead the flood-waters of September and October into embanked fields. When the floods have subsided, crops are sown—mainly wheat, barley, and fodder crops.

Below the dam and below the barrages at Isna, Girga, and Asyut, perennial irrigation is practised throughout the year: water is led by deep canals to smaller canals and channels. Here cotton, sugar-cane, dates, and rice can be grown, as water can be supplied in the hot season when these crops need it. In some parts the water is raised to the fields by power-pumps; in others the peasants raise it by water-wheels worked by oxen or buffaloes, or even by a simple arrangement of bucket and pulley.

At Cairo (q.v.) the Nile enters its delta, a broad, flat, marshy area crossed by many distributaries, and reaches the Mediterranean by several mouths.

From the air a very vivid and clear picture is obtained of the Nile and Egypt, the river and the irrigated strip bordering its banks standing out as a green and fertile ribbon in a desert region.

See also Egypt.

NORTH AFRICA, *see* Algeria; Egypt; Libya; Morocco; Tunisia.

NORTH AMERICA. America was named after Amerigo Vespucci, a Portuguese adventurer who made several expeditions to the continent some years after Columbus discovered the West Indies in 1492. North America stretches from the Arctic Ocean to the Gulf of Mexico and Central America, and lies between the north Atlantic and Pacific Oceans. Its greatest length is about 4,500 miles, while its greatest width is some 3,300 miles. Its area is about 2½ times that of Europe.

Politically, North America is formed by the Dominion of Canada, Newfoundland, the United States of America including Alaska in the extreme north-west, and all of Mexico (qq.v.) except for that part east of the narrow isthmus of Tehuantepec which is counted as part of Central America (q.v.).

High ranges of mountains, including the Rocky Mountains (q.v.), border the west coast of North America. In the centre a vast lowland, drained by several large rivers, stretches from the Arctic to the Gulf of Florida. In the north

NORTH AMERICA

the MACKENZIE flows to the Beaufort Sea and Arctic Ocean. The ST. LAWRENCE flows eastward to the Atlantic, while the MISSISSIPPI (qq.v.) and its tributaries drain almost all of the central U.S.A. to the Gulf of Florida. East of the plains there is hilly country—in the north the plateau-like Laurentian Shield of Canada, and farther south the APPALACHIANS (q.v.) of the United States.

So vast a country has, naturally, a great variety of climate. The far north has a cold Arctic climate; Florida has a sub-tropical climate, tempered sometimes by icy northern winds which blow without hindrance across the great central lowland. Between these extremes there are varieties of cold, cool, and warm climates in which are grown crops ranging from wheat and apples to cotton, sugar, and rice. The continent is rich in forests, both coniferous and deciduous, and has also vast deposits of coal, iron, oil, and other minerals.

NORTHERN LIGHTS, *see* AURORA BOREALIS.

NORTH POLE, *see* POLAR REGIONS.

NORTH SEA, *see* OCEANS.

NORWAY. This is the north-western part of the Scandinavian Peninsula (*see* Map, p. 160). It is roughly equal in area to the British Isles, but it is so mountainous and infertile and has so little mineral wealth that only about three and a half million people live there.

The magnificent west coast of Norway is cut by fiords, long narrow branching inlets of deep water between high cliffs which are edged by steeply rising wooded slopes. These fiords sometimes penetrate 100 miles or more inland and break into many forks. They are fed by rushing torrents and magnificent waterfalls from the mountains. Some fiords, such as the Geiranger Fiord and the northern and southern arms of the great Sogne Fiord, are surrounded by mountain peaks 5,000 and 6,000 feet high. About 2,000 square miles of Norway is covered by GLACIERS (q.v.), rivers of ice, some of which are easily reached from the fiords and provide popular tourist trips. A line of low hilly islands, called skerries, separates and protects the coast from the Atlantic Ocean. The channel between the skerries and the mainland is deep calm water, and provides the easiest means of communication

A VILLAGE ON THE HARDANGER FIORD IN SOUTHERN NORWAY. *Norwegian Official Photo*

between the little villages and towns which have been built wherever there is a patch of flat land. Farms are found perched on ledges high up on the hill-sides.

The long narrow northern strip, the most northern part of Europe, is very mountainous and very sparsely inhabited by fishermen and reindeer-breeders. In central Norway, the fiords continue inland as deep U-shaped fertile valleys cutting into a high plateau, most of which is barren moorland. The farmers in the valleys can sometimes use the high lands for summer pasture for their cattle. Southern Norway is also hilly. There are deep valleys and lakes and small lowlands along the coast. Forests cover much of the hill slopes, and the people are farmers in summer and foresters in winter. Dairying is the most important type of farming, and hay the chief crop, though oats, barley, and potatoes are grown in small patches. Except for modern buildings in the towns, most of the buildings are of wood. The floors are often raised to be above the melting snow, and the roofs are steep. Houses are often decorated with elaborate and beautiful wood carving.

Very many Norwegians are fishermen, and the sheltered coastal waters provide good catches of cod, herrings, and mackerel. The waters round the mountainous Lofoten Islands form one of the finest fishing-grounds in the world. Norwegian boats, however, range much farther afield—as far as the fishing-grounds of North America and Iceland, and the whaling areas of the North Atlantic and the South Antarctic Oceans. In the rivers, salmon and trout are plentiful. Canning of fish and the production of cod-liver oil are important industries, and to meet their needs, factories for making the machinery and the tins have grown up. Although a little iron is mined in Kirkenes in the extreme north, almost all the metals needed have to be imported. The cheapest fuel is electricity, since it can be generated by water-power. It is used in the timber and aluminium industries, the main industries of Norway.

Norway has a cold, rather dry climate, with snow everywhere in winter; but the warm waters of the Gulf Stream help to keep its western inlets from becoming frost-bound. In the extreme north, the sun never sets between the middle of May and the end of July, and this area has been called 'the Land of the Midnight Sun'. But between the middle of November and about 23 January, the sun never rises. Even in the south there is no pitch darkness in the summer nights, but in the winter months it is dark by three o'clock in the afternoon.

The Spitsbergen archipelago (q.v.), which lies several hundred miles north of Norway, in the Arctic Circle, has belonged to Norway since 1920. There is very little permanent settlement; but many people find a livelihood there in hunting and trapping seals, polar bears, arctic foxes, and reindeer (*see* Fur Hunting, Vol. VI), and, recently, rich deposits of coal have been found. During the three months of summer the islands are visited by a great variety of birds.

See also Oslo.
See also Vol. I: Norwegians; Lapps.

NOVA SCOTIA, *see* Canada.

NOVGOROD (New Town) is one of the oldest towns in Russia. In the 9th century, Novgorod and Kiev (q.v.) were the two most important centres of European Russia. In 862, the people of Novgorod, already a town of considerable commercial importance, invited the Viking leader Rurik to rule over them. The descendants of Rurik ruled over Novgorod, and also over Kiev, for several hundred years. Novgorod's position was a particularly fortunate one, as she lay on the route between the Baltic ports of the north and the River Dnieper, which flows across Russia to the Black Sea, the route to Constantinople (*see* Map, p. 459). By the 13th century she had grown into a strong trading city, a member of the Hanseatic League (q.v. Vol. VII), and with a population much larger than she has to-day. So strong was she that the proverb grew up, 'Who can contend with God and great Novgorod?' When western Russia, including Kiev, was overrun with hordes of Mongols and Tartars, Novgorod, protected by her marshes, held out against them; and she retained her independence until, in the late 14th century, she was forced to pay tribute to the growing state of Moscow (q.v.). In the 15th century Ivan the Great finally subdued the city and brought her under the control of Moscow. In 1570 the cruel Moscow emperor, Ivan the Terrible, sacked the city and slaughtered at least 15,000 of her people. Novgorod has never recovered anything like her medieval splendour. During the Second World War she again suffered severe damage.

What remains of the old city is typical of medieval Russian architecture—elaborate buildings with highly decorated pillars and alcoves, queerly twisted shapes, and many domes, both large and small. Brilliant colours are characteristic—the domes are often gilded or painted blue with gold stars. The influence of Byzantine Art (q.v. Vol. XII) is strong: the Cathedral of St. Sophia, for instance, built in 1045, was designed by an architect from Constantinople.

Novgorod must not be confused with another important Russian city, Nijni-Novgorod, now generally known as Gorki, situated at the junction of the Rivers Volga and Oka in central Russia. Nijni-Novgorod is best known because of its famous trade fair, started as early as 1366, and visited by merchants from all over Europe and the East. The fair has now been discontinued, and the city is important for its great motor-works.

See also R.S.F.S.R.

NUCLEON, *see* Atom.

NYASALAND, *see* East Africa.

O

OASIS, *see* DESERTS.

OCEANS. 1. Almost three-quarters of the surface of the earth is covered with water, the most extensive areas of water being the great oceans—the Atlantic, Pacific, Indian, Arctic, and Antarctic.

The Atlantic Ocean is bounded by the east coast of America and Greenland and by the west coasts of Europe and Africa. It extends from latitude 40° S. to the Arctic Circle. The indented coasts surrounding it enclose inland seas, like the North Sea, Baltic, and Mediterranean in Europe, and the Caribbean in America.

The Pacific Ocean is bounded by the west coast of the Americas and the east coast of Asia. In the north it communicates with the Arctic by the narrow Bering Straits; and southwards it extends to latitude 40° S. The area of the Pacific is greater than that of the whole land area of the world.

The Indian Ocean washes the east coast of Africa and, in the south, merges into the Antarctic. It borders Peninsular India, Burma, Malaya, and the East Indies, and connects with the Red Sea and Persian Gulf.

The Arctic Ocean lies between the north polar ice-cap and the north coasts of Asia and America; the Antarctic, or Southern Ocean, extends from latitude 40° S. to the ice-covered Antarctic continent, which surrounds the South Pole. Large areas of these oceans are frozen over for part of the year (*see* POLAR REGIONS).

2. OCEAN BASINS. The ocean beds have been explored by soundings, and vast hollows and ridges have been found to exist in their depths. The continents are surrounded by what is known as the 'continental shelf', built up of the sediments brought down by rivers and deposited near the coasts. This 'shelf' slopes gradually from the shore line to a depth of about 100 fathoms (600 feet). From its edge the bottom dips sharply, so that the depth of the ocean becomes rapidly greater.

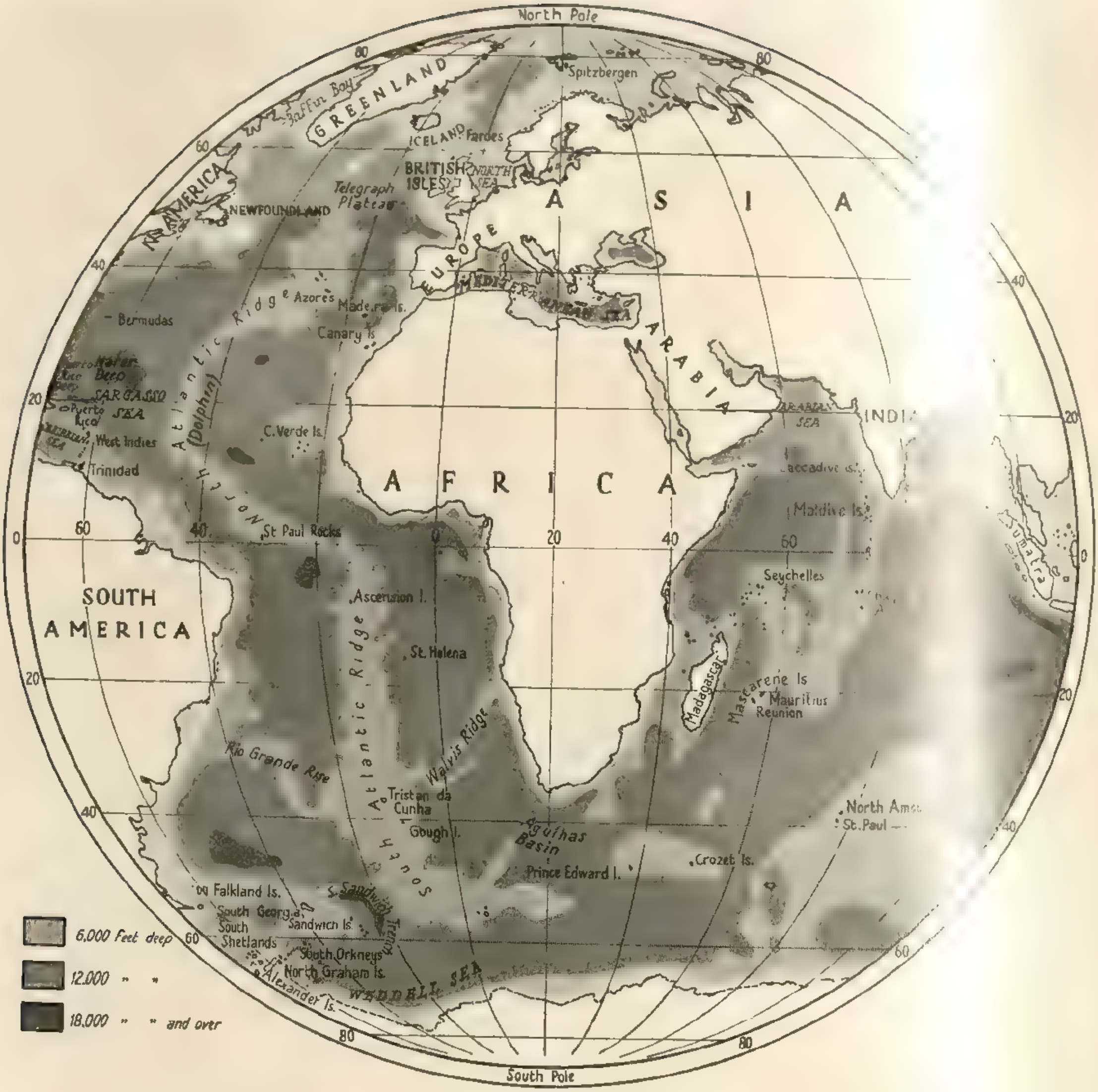
The Atlantic basin is divided into two great hollows by the Dolphin Ridge, which extends along almost its entire length from north to south, coming to the surface at the Azores and Ascension Island. In the deep troughs on either side of this ridge the ocean bed descends to more than 3,000 fathoms (18,000 feet). The deepest sounding recorded in the Atlantic—in the International Deep, north of Puerto Rico—shows a depth of more than 5 miles.

The Pacific basin is a vast hollow with an average depth of more than 2,000 fathoms (12,000 feet). It contains innumerable islands, of volcanic or coral formation, mainly in the centre and west. These range in size from huge islands, like Borneo and New Guinea, to tiny 'atolls' less than a mile across (*see* PACIFIC ISLANDS). The Pacific has not yet been fully explored by soundings; but near the Fiji Islands a deep trough has been found going down to more than 3,000 fathoms (18,000 feet). The greatest recorded ocean depth—35,433 feet, or nearly 7 miles—is found near Mindanao in the Philippines, in part of the Philippine Trench, a trench 20 miles wide, which stretches off the coast of Japan and the Philippines for 1,000 miles.

The basin of the Indian Ocean is divided by a ridge which extends from Madagascar to Ceylon, rising to the surface in the Seychelles and the Maldive Islands. The deepest part of the Indian Ocean is between north-west Australia and Java.

The ocean floors are covered with deposits called OOZES (q.v.).

3. PROPERTIES OF OCEAN WATER. The water of the oceans contains nearly 200 times as much dissolved solids as river-water, each 100 lb. of sea-water containing about 3·5 lb. of dissolved solids—which give the water its salty taste. The reason for this concentration is that the seas and oceans are continually losing by evaporation the water poured into them by the rivers, whereas the salts dissolved in the water do not evaporate, but remain behind. So, as the centuries pass, sea-water all over the globe is gradually becoming more salty. In the totally enclosed DEAD SEA (q.v.), where evaporation is extremely rapid, the water is now so salt that no

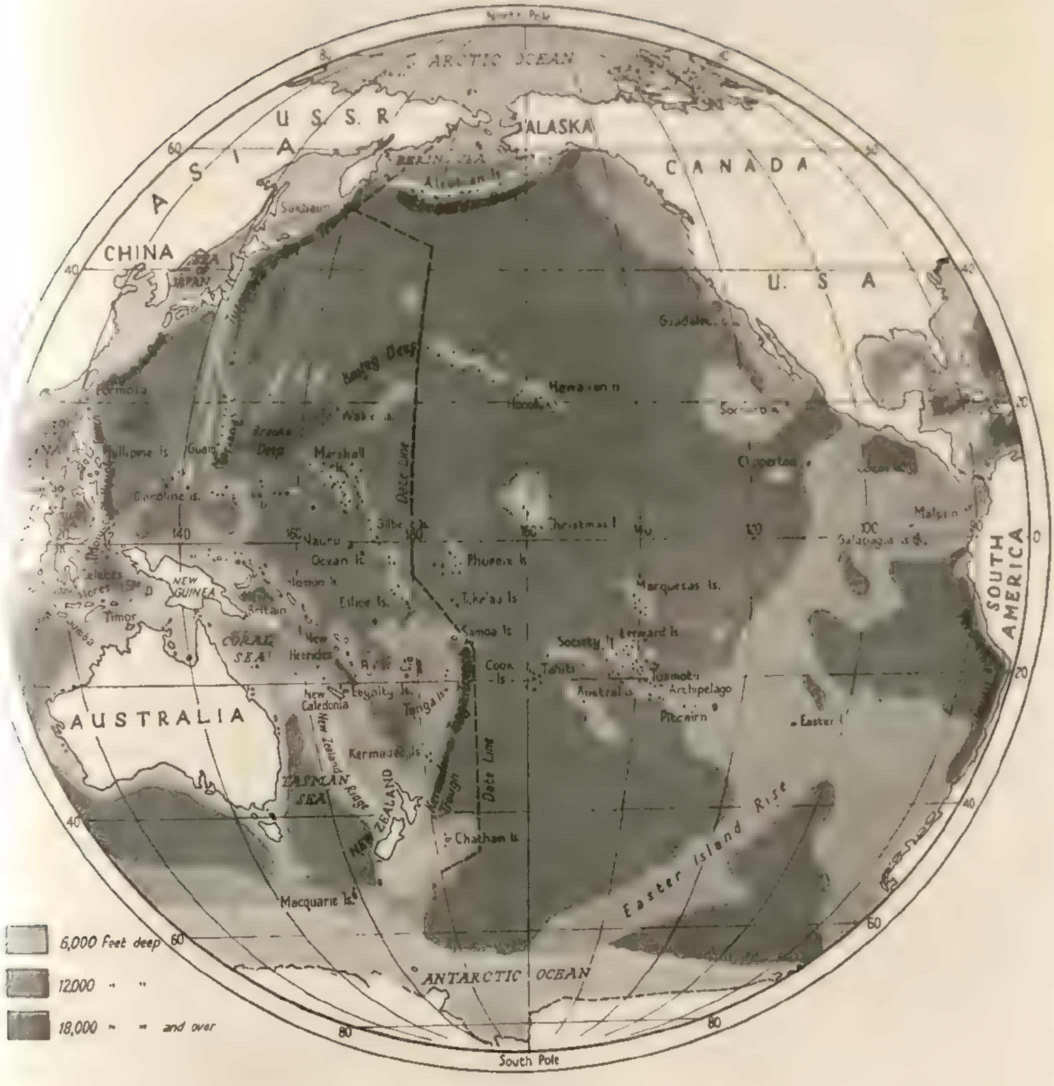


THE ATLANTIC AND INDIAN OCEANS

life can exist in it. Of the salts in sea-water, 88·5% are in the form of sodium and magnesium chlorides, the remainder being sulphates of magnesium, calcium, and potassium.

The surface temperature of the oceans is naturally highest at the Equator, about 80° F., and decreases gradually towards the Poles; but at a depth of 400 fathoms the temperature in all parts of the oceans is constant at about 40° F. This means that in tropical waters there is an abrupt drop in temperature with increasing depths. Below 400 fathoms the fall in temperature to the ocean bottom is very gradual.

4. The Effect of Wind and Tides. The surface of the oceans is in constant movement owing to the action of Wind and Tides (qq.v.); but this agitation of the ocean is confined to the upper 100 fathoms. Winds affect the ocean surface by ridging it up in waves which advance before the wind as a line of rollers. On reaching the shore, the lower part of the water is retarded by friction with the beach, and the upper part topples over, forming a breaker. If the wind reaches gale force, it whips the crests of the rollers off in spray. An on-shore wind piles layers of sun-warmed water against the coast, where it is



THE PACIFIC OCEAN

banked up to a considerable depth, forcing the lower layers of cold water to move seaward as an 'undercurrent'. An off-shore wind blows the warm surface water seaward, so that cold water wells up to take its place as an off-shore current.

Tides (q.v.) have little effect in the open ocean, the rise being no more than 2 feet; round the coasts, however, shallower water and the shape of the land combine to give tidal differences of many feet. The rise at Spring Tide in Cardiff docks, for instance, is 42 feet.

5. Ocean Currents are narrow tracts where water flows steadily and strongly, like a river within the ocean. There is some doubt about the cause of these currents—but undoubtedly the wind is one powerful factor. The direction of flow is controlled by prevailing winds, by the shape of the coast-line bordering the oceans, and by the rotation of the earth on its axis. The general circulation of ocean currents is clockwise in the northern and counter-clockwise in the southern hemisphere.

Near the Equator the general movement of ocean currents is in a westerly direction and is known as the Equatorial Current. In the Atlantic, part of this warm-water current is swept into the

Gulf of Mexico and forced out through the Straits of Florida as the Gulf Stream. This is a river of salt warm water (81° F.) about 50 miles wide at its narrowest and 350 fathoms deep, flowing at a speed of 5 miles an hour. It sweeps northwards and is carried eastward across the Atlantic in the general clockwise circulation of the ocean. On its way it spreads out, grows cooler, and mingles with the general current carrying surface water from the tropics to the coasts of Norway and Britain. It is from this source that the prevailing south-westerly winds are supplied with warmth and moisture to modify the climate of western Europe (*see* WEATHER). A branch of the Gulf Stream, called the Canaries Current, flows south past the Canary Islands (off the north-west coast of Africa) and rejoins the Equatorial Current to complete the circulation.

In the South Atlantic, the Equatorial Current is deflected by the bulge of South America and flows south as the Brazil Current. On meeting the cold Antarctic Current which circulates round the globe in an easterly direction about latitude 40° S., it is swung eastwards, to flow north along the west coast of Africa as the cold Benguela Current.

A similar circulation occurs in the Pacific Ocean. The Equatorial Current flows from east to west, and part of it branches northwards as the Kuro Siwo Current, off the coast of Japan. This current crosses the Pacific about latitude 40° N. and flows southwards near the coast of America to rejoin the Equatorial Current. In the South Pacific the flow is counter-clockwise, from the Equatorial Current southwards to join the Antarctic Current, and northwards off the coast of Peru. The Peru Current is cold (*see* Map).

6. THE OCEANS AND CLIMATE. Ocean currents carry the warm water of the tropics to colder latitudes, and in these latitudes winds from the ocean moderate the land temperatures. On the other hand, the cold currents off the west coasts of the continents in tropical latitudes (Benguela and Peru Currents) reduce the land temperature.

The ocean heats and cools more slowly than land surfaces under the influence of the sun, and the differences thus caused in pressure over land and ocean give rise to land and sea breezes as well as to the MONSOONS (q.v.). It is chiefly the ocean which provides WATER-VAPOUR for the WINDS which deposit it as RAIN on the land (qq.v.). Again, the flat and level surface of the oceans allows large atmospheric phenomena to develop with less interference than they encounter over land. In short, all over the world the oceans play a most important part in determining not only WEATHER but also CLIMATE (qq.v.).

OHIO, U.S.A., *see* UNITED STATES OF AMERICA.

OIL, NATURAL. The only oil found on a large scale in its natural state is 'petroleum', the source of the familiar motor-spirit and of other useful fuels and lubricants. There is another natural mineral oil, called 'shale-oil' from the rocks in which it is found (*see* CLAYS AND SHALES); but although some shales are so richly oily that they can be lighted with a match, the oil itself has to be freed by an industrial process (*see* SHALE-OIL, Vol. VII).

Natural petroleum is found in many forms, from a thin, almost colourless liquid to a brown or black treacly substance, which sometimes has a greenish look. Petroleum has an unmistakable smell and is always more or less inflammable. In one form or another it has been known, and to some extent used, since long before written history. At Baku, on the Caspian Sea, now the centre of a great oil-producing district, the self-ignited fountains of petroleum were worshipped as 'sacred fires' and were visited by pilgrims from as far away as India. There were oil-pits near ancient Babylon, and in China and Burma there are still traces of very early oil-workings.

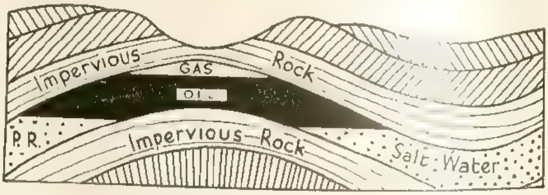


FIG. I. SECTION OF THE EARTH SHOWING AN OIL RESERVOIR
P.R. = pervious rock

Many of the earliest uses of petroleum employed it in its more solid form, ASPHALT (q.v.), and are described in that article; but there can be little doubt that it was used also as a lubricant and for lighting purposes. Certainly 'burning water' was known to the Japanese in the 7th century, and in North America oil-workings have been discovered dating back between 500 and 1,000 years. The medical properties of petroleum have long been known, and it was

used in ancient days for the treatment of wounds and skin diseases—just as its modern derivative, 'vaseline', is used to-day.

Petroleum, its natural GAS (q.v.), and asphalt are three forms of a substance called 'bitumen' which occurs very widely over the earth in rocks of every geological age. Like COAL (q.v.), it has been formed by natural processes out of deposits of organic matter. But whereas coal is derived mostly from the trees, ferns, and plants of the Carboniferous Age, it is now thought probable—though there is still some doubt—that petroleum has been formed principally from the fatty matter of minute salt-water creatures called 'foraminifera', and microscopic plants, 'diatoms', which go to make up the ocean OOZES (q.v.). As these died, they sank to the ocean floor, and were preserved from decay by being covered up with mud. Gradually they formed a sediment and, as this grew, the lower layers were pressed deeper and deeper into the Earth's crust. Here, under great pressure and perhaps under considerably higher temperature, the organic matter was transformed into oil, which filled the crevices between the small particles of mud.

Later, as the oil-bearing layers were pushed still lower, the pressure on them grew greater and greater still, until the particles of mud were forced tightly together and the oil was squeezed out. It could not escape downwards, for there the pressure was still greater: it therefore made its way upwards into any bed that was more porous than the mud in which it had been formed—such as sands, sandstones, and some limestones. Natural gas, produced from the organic material in the same way as marsh gas is formed, preceded the oil, salt-water followed it, the colossal pressure squeezing out the remains of the water in which the mud had been deposited originally. The gas, oil, and water rose to a porous part of the earth's crust where, with an impervious rock layer above (sometimes called the 'cap rock') and another impervious layer below, they formed an oil reservoir or pool (Fig. 1).

It will be clear from the above that SALT (q.v.) or brine is often to be found in company with oil deposits. Rock-salt is impervious to petroleum; and so, in the folding of the earth's crust by the geological processes described in ROCKS, FORMATION OF, it often happens that strata of rock-salt are raised to form barriers

A NEW CANADIAN OIL WELL
Impurities are burned off as the oil gushes from the earth. It is later piped into storage tanks
Associated Press, London

preventing the flow of oil to the sides. For instance, where the various strata lie in gentle undulations, oil is likely to be found under the crest of a 'wave', and salt under the hollow of a 'trough'; or in another case the oil deposit may be in the form of a lens confined between an underlying basin of rock-salt and a cap rock like an inverted bowl above it. Or again the salt may be pushed up through the oil, forming what is called a 'salt-plug'.

Underground oil is very often under great pressure, which may be due either to the accumulation of gas above it or, more rarely, to the weight of the surrounding water or brine—in which case conditions are like those of an artesian well (*see* WELLS AND SPRINGS). When the cap rock is pierced, the oil may shoot out in a fountain many feet high, releasing thousands of tons a day for a period of months, until the pressure is gradually exhausted. Such 'gushers',

as they are called, are often encountered in the Russian oil-fields, where pressure is particularly high. Apart from the great waste of oil, if the petroleum happens to catch fire either spontaneously or for any other reason, enormous conflagrations may result.

The presence of underground oil may be indicated at the surface by springs or pools of oil (at Baku the soil for miles around is impregnated with petroleum), by films of oil on stagnant or running water, or by the emission of gas—which also may be noticeable in water as bubbles or may be detected by smell alone. By exposure to the atmosphere, petroleum may have thickened and hardened into lakes of ASPHALT (q.v.) or may ooze from the ground in this state, as in the famous Pitch Lake in Trinidad.

Petroleum was first produced on an industrial scale in Pennsylvania, U.S.A., in 1856; Canada and Ohio soon followed. To-day about half the world's oil-supply comes from America, the other half being contributed by the U.S.S.R., Roumania, Burma, Peru, Venezuela, the Dutch East Indies, and Iran (Persia). The existence of oil in England has long been known. There are occurrences of natural gas, as at Heathfield in Sussex where it was used to light the railway station at night, and there have been leakages of oil in many places. But borings failed to produce oil in commercial quantity because the arrangement of the rocks in the areas tested was not suitable for the formation of an oil-pool. The outbreak of the Second World War caused special efforts to be made, however, and as a result, four oil-fields of modest but useful size in Nottinghamshire and a small field in Lancashire, were discovered. There is prospect, too, of other oil-fields being found not very far away.

See also Vol. VII: OIL, MINERAL.

OKLAHOMA, U.S.A., *see* UNITED STATES OF AMERICA.

ONYX, *see* AGATE.

OOZES. The material found on the floor of the ocean is of quite different origin from that carried down to the sea by rivers and deposited within a few hundred miles of the shore, where it ultimately forms 'sedimentary rocks'. The ocean oozes have not been brought by rivers from the land, but have accumulated, with almost infinite slowness, from the remains of animals and plants living in the ocean. For the pressure in the ocean, which is mostly over $2\frac{1}{2}$ miles and in some places over 6 miles deep, is so enormous that the remains of animals and plants mostly dissolve as they sink, even though they would not dissolve in water at ordinary pressure. Among sedimentary rocks, 'chalk' is almost the only one to have its origin in an ooze.

Knowledge of ocean oozes has been obtained mainly by expeditions equipped for dredging at great depths. The oozes consist mainly of very small shells. Where one kind of shell is very common the ooze is named after it; but the types of ooze pass imperceptibly one into another.

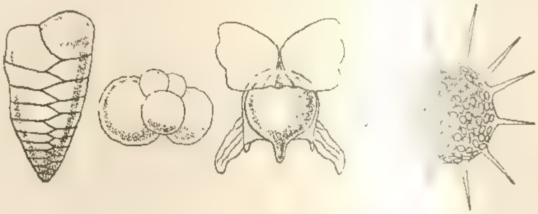


FIG. 1. FORAMINIFERA, GLOBIGERINA, PTEROPOD, RADIOLARIA, THE ORGANISMS WHICH FORM OOZE

After Henry Wood's 'Palaeontology', Cambridge University Press

'Globigerina ooze' covers the floor of 50 million square miles of ocean. It consists of the remains of minute animals known as 'foraminifera' or hole-borers. They have hard shells made of calcium carbonate, which down to a depth of about 2,500 fathoms does not dissolve easily. Globigerina are the most common of the many kinds of foraminifera. Under suitable conditions such oozes, when deposited in comparatively shallow oceans, become transformed into chalk such as now underlies much of southern England.

At depths greater than 2,500 fathoms the shells of most foraminifera are dissolved, and only shells composed of silica, which is far less soluble in water than calcium carbonate, are found. Shells of minute creatures called 'radiolaria' are most common; but there are also skeletons of sponges and shells of diatoms. Radiolarian ooze covers less than $2\frac{1}{2}$ million square miles of ocean bed, and is commonest at about 3,000 fathoms. Below this depth even these hard shells begin to disappear, until finally only the deposit known as 'red clay' is found. Red clay is derived from wind-borne dust or from meteorites. It accumulates so slowly that the shark's teeth lying on the surface often include those of forms which have been extinct for many millions of years. Red clay is more

wi- ely spread then Globigerina ooze and occupi- the floor of over 51 million square miles of oc an.

nost all life in the sea is dependent, d ctly or indirectly, upon microscopic plants c d 'diatoms'—which are often referred to, t efore, as 'the pasture of the sea'. These exist i ater all over the world down to a depth of t 100 fathoms: below this, light is unable to p etrate, and so they cannot live. Their hard s ls of silica are found in all oozes. Diatoms particularly abundant round the Antarctic inent and in the Arctic circle, where there about 200 million diatoms in every cubic of water. There the deposit on the ocean fl or consists mainly of diatom shells and is fore known as 'Diatom ooze'.

teropod ooze' is a deposit consisting mainly e shells of pteropods, very small shell-fish onging to the winkle family. It is found on es of the ocean floor in some warm areas of bigerina ooze.

also EARTH, HISTORY OF, Chart; MOUNTAIN BUILD- LIMESTONE; OIL, NATURAL; MINERALS.

AL. The word 'opal' is believed to be ived from the Sanskrit *upala*, meaning 'a ious stone'. Probably no gem-stone has had re superstition attached to it—at one time it s so widely believed that opals brought ill k to their wearers that the demand for them clined and their price fell.

Opal is oxide of silicon with a varying amount of water. It is not hard, and is easily damaged nd scratched. It is porous, and should never be immersed in liquid, while heat may spoil its colour. It is not crystalline, but results from the cracking, while cooling, of a jelly-like mass of silica. The cracks were filled later by opal substance with a different proportion of water and, in consequence, a different power of 'refraction' (*see* WAVE MOTION). This causes opalescence, as the distinctive play of colour characteristic of opal, is called.

There are two kinds of precious opal—black and white. Both have opalescence. The most expensive has 'orange pin fire'. Next come 'green flashes', then 'red flashes', and, lastly, 'blues'. 'Fire-opals', which range in colour from yellow to reddish-yellow, show no opalescence. The water-opals of Mexico look like drops of water brilliantly flashing many colours.

The oldest-known opal-mines are in Hungary, and the opals the Romans knew probably came from there. To-day the majority come from New South Wales and Queensland, where they are found in sandstone rich in iron. The Hungarian opals are in cavities in decomposed iron-bearing lavas. Stones have been found recently in Nevada, in the U.S.A., but they break very easily. Opals cannot be manufactured artificially.

See also MINERALS.

ORANGE FREE STATE, *see* SOUTH AFRICA.

OREGON, U.S.A., *see* UNITED STATES OF AMERICA.

ORES, METAL, *see* METAL ORES.

ORKNEY ISLANDS. This group of islands is separated from northern Scotland by the Pentland Firth, 6 miles wide. Violent tidal streams rush through this narrow stretch of water, throwing up so much spray that the little island of Stroma is sometimes completely hidden. The unpleasant sea journey can now be avoided, however, as there are air services (*see* Map, p. 396).

The Orkneys, like the mainland opposite, are of red sandstone which has weathered and been worn by the sea into rather flat undulating plateaux edged by steep cliffs. Some of the cliffs of Orkney are among the most spectacular in Europe: St. John's Head in Hoy, for example, falls perpendicularly 1,400 feet to the sea; and near it is an isolated rock pillar, 450 feet high, known as the Old Man of Hoy.

Of the sixty-eight islands and islets in the Orkneys, twenty-nine are inhabited, the total population being some 21,000. The biggest island, Pomona or Mainland, has the two largest towns, Kirkwall and Stromness. To the north of it lie Rousay, Stronsay, Sanday, Westray, and North Ronaldsay. To the south are Hoy and South Ronaldsay. Scapa Flow, important in both world wars as a naval base, and the place where the remains of the German Grand Fleet scuttled itself in 1919, is enclosed by Mainland, Hoy, and South Ronaldsay. Some 26 miles to the north-east of the Orkneys lies the isolated Fair Isle, a sanctuary for birds, inhabited by some eighty people.

Most of the Orcadians, or people of Orkney, are farmers. The farms are small but fertile, and grow good crops. Horses, sheep, and cattle are

THE HARBOUR AND TOWN HALL, OSLO. *Norwegian Official Photograph*

kept, and poultry-farming is a flourishing industry. Fishing as a livelihood is less popular than it was.

The Orkneys were inhabited in prehistoric times, as is shown by the rings of standing stones, in particular the Ring of Brogar and the Ring of Bookan, and by the Pictish village, believed to date from 500 B.C., which has been excavated at Skara Brae. Kirkwall, the capital of the Orkneys, was already a small town in 1046, and now has about 4,400 inhabitants. Among its fine old buildings are St. Magnus Cathedral, parts of which date from the 13th century when the Orkneys were part of the kingdom of Norway. The Earl's Palace and the Bishop's Palace, where King Hakon of Norway died after his defeat by the king of Scotland, are also fine 13th-century buildings.

See also SCOTLAND.

OSLO. In 1925 Oslo dropped the name of Christiania, by which it had been known since 1624, in favour of its original name. It is the capital of Norway—but the kings of Norway are crowned at Trondheim, a former capital.

Oslo owes its charm both to its fine situation on the waters of Oslo Fjord, amid pine-wooded hills, and to the pleasant layout of its broad streets and tree-lined squares. There are two harbours, separated by a triangular peninsula. The Björviken, on the east, takes big steamers, the Piperviken takes smaller ships.

The Fortress of Akershus on the peninsula is one of the few ancient buildings of the city, for the old wooden houses have been replaced by stone, brick, or concrete buildings, generally plain but dignified in design. Most of the important buildings are in or near Karl Johans Gate, the main street of the city. The Royal Palace is on a hill at the north-east of this street. From the park surrounding it a wonderful view of the city is obtained.

Oslo has an important shipbuilding industry and, in addition, manufactures paper, pulp and timber goods, foodstuffs, and chemicals. With the city are closely associated two famous Norwegians—IBSEN (q.v. Vol. V) and Björnson, a poet, novelist, and dramatist, who was responsible for introducing to the annual festival on 17 May the Procession of Children, which is one of its most charming features.

See also NORWAY.

OTTAWA. Since 1858 this city, in the Province of Ontario, has been the capital of Canada. Before 1858 it was a small lumber town, origi-

THE PARLIAMENT BUILDINGS, OTTAWA. *Royal Geographical Society*

ally known as Bytown. It is admirably situated n the fringe of the gently sloping Gatineau Hills, overlooking the broad River Ottawa; but 's beauty has been much spoiled by the industrial city of Hull on the opposite bank, and by he dingy power-houses which hide the cascading falls of the rivers. Ottawa is on the main transcontinental routes of both the Canadian Pacific and the Canadian National Railroads, and it has excellent communications, by water as well as by rail, with the other great cities of Canada, and with New York. The city clusters round Parliament Hill, on which stand its most magnificent buildings. Here are the meeting-places of the Canadian Senate and House of Commons, while rising high above them is the Tower of Victory, a remarkably beautiful memorial dedicated to the memory of Canadian soldiers who fell in the First World War. The city is divided by the Rideau Canal into the Lower Town, which is mainly French, and the Upper Town, which is mainly English. Most of the population of Ottawa are civil servants; and when Parliament is in session, or when an important conference (such as the Empire Conference of 1932, known as the Ottawa Conference) is being held, the city is thronged with people. On the outskirts of the city is Rideau Hall, the residence of the Governor-General of Canada. This is guarded by the Royal Canadian Mounted Police, whose headquarters also are in Ottawa (*see* CANADIANS, Vol. I).

See also CANADA.

OZONE. It is often said that the reason why seaside air is so healthy is because there is a great deal of ozone in it. This is quite untrue.

Ozone is a form of oxygen in which each molecule is composed of three atoms instead of the normal two. It is formed when an electric discharge passes through air; and, as it has a characteristic smell, this used to be considered 'the smell of electricity' (often to be noticed in underground electric railways). The great value of ozone in purifying the air is due to its readiness to shed the extra atom and turn into ordinary oxygen. Part of the feeling of 'freshness' in the air after a thunder-storm may well be due to the liberation of ozone by the flashes of lightning.

Ozone is particularly plentiful in the 'stratosphere', which is the name given to one of the layers of the ATMOSPHERE (q.v.).

P

PACIFIC ISLANDS. The Pacific is by far the greatest of the oceans, so great that it could contain the land surface of the entire globe and much more. Its span at the equator is 10,000 miles, and it contains the world's most profound submarine depths. Its islands and islets are literally uncounted (*see* OCEANS). We are concerned here with what are commonly called the South Sea Islands, that is to say, those island groups originally discovered and still inhabited by the POLYNESIAN, MICRONESIAN, and MELANESIAN peoples (qq.v. Vol. I). The Pacific Islands include New Guinea, the second largest island in the world. They also include thousands of coral atolls, some inhabited, some not, some mere specks on the ocean. On some

PAGO-PAGO, SAMOA. *Paul Popper*

islands there are mountains [illegible]o feet; on others the highest point is less [illegible] feet above sea-level.

Although almost all the Sou[illegible] Islands lie within the tropics, it is nat[illegible]t such a variety of structure and clim[illegible]ld lead to a great variety of vegetation. I[illegible]he tropics height alone can produce in th[illegible]ic islands graduations of temperature and environment that range from bitter cold on b[illegible] mountain-tops, to steamy valleys clad with dense bush fed by a torrential rainfall, or to the h[illegible] unhealthy mangrove swamps along the coasts. The atolls, or 'low islands', on the other hand, covered as they are with only the thinnest sprinkling of soil formed by disintegrating fragments of coral, support little vegetation other than the coco-nut and the pandanus palm or screw pine. Their scanty rainfall is subject to periodic droughts so drastic that even the nuts may be destroyed and the natives at times brought near starvation. In compensation, the sun shines and the breezes blow on their open airy rings of coral to an extent unknown in the dank jungles of some of the great islands of Melanesia.

Tropical forests cover many of the Pacific Islands. In these there are many kinds of trees including coco-nut and pandanus palms. Reeds and grasses cover the open and swampy areas on volcanic islands. There are few indigenous flowers and shrubs, though on the more fertile soils imported plants such as the beautiful cassias, tulip-trees, and flame-coloured flamboyants do well. In the islands that lie in the hurricane belt, in particular Fiji and Samoa, there is periodic devastation of whole crops by violent TORNADOES (q.v.) which are usually accompanied by destructive flooding. Rivers have been known to rise as much as 70 feet in a day, destroying villages and plantations.

Every island, volcanic or atoll, produces the coco-nut palm, which grows freely without much cultivation and yields COPRA (q.v. Vol. VII), the dried inside of the coco-nut. Production of copra by large European-owned companies and by white and native planters has long been the staple industry of the Pacific Islands. Modern chemical science, however, and the production of vegetable oils nearer the centres of consumption in Europe and America have combined to make prices fall, and copra appears to be a declining industry. So far there has been no great attempt to replace it, though in some

HAWAII
In the distance is the volcano Mauna Kea. *E.N.A.*

..as other industries have been developed. ..ld, for instance, is obtained in Fiji and New ..uinea, sugar is grown in Fiji and Hawaii, ..cean Island and Nauru produce phosphates. ..here is a flourishing cocoa industry in Samoa ..nd New Guinea, and vanilla is grown in Tahiti ..nd New Caledonia. All the islands, except ..ose of Micronesia, produce in lesser or larger ..mounts bananas, pine-apples, and other fruit, both wild and cultivated, such as oranges, lemons, pawpaws, and melons. For their own consumption Pacific Islanders grow root-crops, mainly taro, yams, and sweet potatoes. Throughout Polynesia and Fiji the natives grow large quantities of kava, a root from which is made an intoxicating drink, used on ceremonial and other occasions.

There are few animals, except birds. Even in the larger islands there are no wild beasts except wild pigs. These were introduced in some of the islands in Captain Cook's time, and since then they have spread to nearly all the islands of the South Seas. There are a few varieties of snakes, mainly non-poisonous. Birds, especially parrots, are found in great variety in all the forests, and round the coasts and on the atolls there are many kinds of sea-birds. The waters are rich in fish, some of which, like the shark, are dangerous, and there are large numbers of turtles, which are regarded as great luxuries. Most islanders are expert fishermen—and fish is a most important part of their diet.

Since the epic voyages of the Polynesians, there has been little communication between the island groups until modern times. Now, air and sea communications are being developed, especially between those islands lying on the route between the United States of America, New Zealand, and Australia. Within the island groups, communication is by coastal steamer or by cutter or motor-launch, and in the more backward regions by canoe. On the larger islands, the more developed areas have internal road systems with a certain amount of motor traffic, while in the less developed areas travel is still by canoe along rivers, on horse-back, or on foot through the thick jungle.

It is difficult to describe the Pacific islands except in general terms, as there are so many groups, each with characteristics of its own. They have in common that they are remote, non-industrial, sparsely populated, and of little importance except as air-bases and naval ports. Their beauty, however, has cast a spell on men's imagination ever since their discovery.

See also CORAL ISLANDS.

PACIFIC OCEAN, *see* OCEANS.

PAKISTAN, DOMINION OF. On 15 August 1947, British India was divided into two Dominions—Pakistan and India. Pakistan includes the former provinces of Sind, North-west Frontier Province, Baluchistan, and parts of the Punjab and Bengal, as well as some of the princes' states in the north of India. There are two parts of Pakistan, separated from each other by territory belonging to the Dominion of India. Pakistan is the country of the Moslems, followers of ISLAM (q.v. Vol. I). Its capital is Karachi, in Sind, on the north-west coast.

See also INDIA.
See also Vol. I: INDIAN PEOPLES; INDIANS, HILL TRIBES.

PALESTINE. This country—the 'Holy Land', strangely enough, of Jews, of Moslems, and of Christians—took its name from the Philistines who lived on its coastal plain in Bible times. Lying at the south-eastern corner of the Mediterranean Sea, it is bounded to the east by the deep valley of the JORDAN (q.v.), beyond which lies Jordan, formerly Transjordan, a huge plateau from 2,000 to 4,000 feet above sea-level, cut by fertile valleys and very sparsely peopled by Arabs. Palestine proper, west of the Jordan, is about the size of Wales, being 143 miles in length from Dan in the north to Beersheba in the south, and averaging 40 miles in width from the Mediterranean to the Jordan. JERUSALEM (q.v.) and the ports of Haifa, Jaffa, and Tel Aviv are the only large towns. In the north are the hills of Galilee, the southern end of the mountains of Syria and Lebanon. Between them and the long ridge of hills which rises steeply from the coastal plain to the west, and the deep rift of the Jordan valley to the east, is the fertile Plain of Esdraelon (*see* Map, p. 17).

The climate is pleasant. It seldom rains between the end of April and the beginning of October, and in these months gloriously sunny days are assured. Spring and autumn are like good British summer weather. Winter is short, but cold and wet, and though snow falls in the hilly districts it seldom lies long. Fires are necessary only from November to March. July and August tend to be too hot for Europeans, but are not unbearable. The most trying periods are during *Khamsins*, when for three to five days a south-east wind brings great heat from the Arabian Desert.

Palestine differs very much in looks from summer and autumn to winter and spring. In

A VALLEY NEAR JERUSAI
Matson Photo Service

summer and autumn everything is scorched by the fiery sun, and the whole land is tawny in colour. After the winter rains and until early summer, vivid green is the predominating colour. Few sights can be more lovely than the varied carpet of spring flowers on the hill-sides, plains, and valleys. There are scarlet anemones, delicate pink cyclamen, blue cornflowers and lupins, heather-purple wild campion, brilliant narcissi, and yellow daisies. The air for miles round Jaffa and the Plain of Sharon is filled by the sweet scent of orange blossom, and later in the year there are lilies, tulips, and orchids.

Olives, grapes, figs, and pomegranates are grown on terraces on the lower hill-slopes. Sharon is known for its oranges, lemons, grapefruit, and bananas. Dates come from Jericho in the Jordan valley. Sometimes as many as four crops of wheat or barley are reaped from the same field in one year. There are flocks of sheep and goats on the hills, and herds of cattle on the rich pastures of Samaria.

Until recently, Palestine's industries were based on its main crops. Oranges were exported from Jaffa, soap was made at Nablus from olive oil, and light country wines came from the grapes. To-day, in addition to those activities, building cement is manufactured, potash is

...acted from the DEAD SEA (q.v.), oil is ...ned at Haifa (the terminus of the oil pipe-line from Iraq), diamonds are cut and polished, fruits, jams, and juices are tinned for export, ... leather goods, medicines, sweets, and chocolate are made for local and Middle East markets.

There are two main peoples. There are Arabs ...h leisurely ways and charming manners, ...wing traditional laws and customs and ...ring a flowing *burnous* or robe. Their traditional head-dress is composed of a circle of ...broidered rope (the origin of the kingly ...wn) laid over a woven white shawl which ...vers the head and protects the back of the ...k from the powerful sun, or the face from the ...ifting sand of the desert. Then there are Jews, ...ually in European dress, forceful in personality, ...ed by mystic faith, adopting Western methods ...agriculture, building new colonies, and setting ... new industries in the land which they claim ... the historic home of their forefathers and from ...hich they had been exiled since the destruction ...f Jerusalem in A.D. 70 by the Romans. In 1949 ...e independent Jewish state of Israel was established in Palestine. Jerusalem is the capital of ...srael.

See also Vol. I: ARABS; JEWS.

PAMIR MOUNTAINS, *see* HIMALAYAS; ASIA.

PAMPAS, *see* GRASSLANDS; ARGENTINA.

PANAMA. This Central American republic is best known because of the great PANAMA CANAL (q.v. Vol. IV), completed in 1914, which connects the Atlantic and Pacific Oceans through the narrowest part of the long neck of land joining North and South America. The Panama Republic is cut in two by an international canal zone, extending about 5 miles on each side of the canal. The long mountain range, which runs all through CENTRAL AMERICA (q.v.), drops to about 300 feet above sea-level at the place where the canal was cut; and this low saddle in the mountains was also used as a route for the railway from Colon on the Atlantic side to Panama City on the Pacific.

The tropical climate and the fertile soil produce rich harvests. On the coastal lowlands, bananas, cacao, coco-nuts, rubber, and sugar are cultivated. Higher up, coffee is grown and cattle reared. Much of Panama, however, is uninhabited. PEARL FISHING (q.v. Vol. VI) is important, and mother-of-pearl a profitable export.

Panama City, the capital, is an attractive cosmopolitan city, but with a definite Spanish character. The cathedral, built in 1760, its twin towers inlaid with mother-of-pearl, faces the main square in which are other fine buildings. Old Panama, founded in 1519 and situated some 5 miles north of Panama City, was the first European settlement on the mainland of America. It was sacked by Morgan, the pirate, in 1671, and nothing is left of its cathedral except one tower, now overgrown with creepers and grasses.

See also CENTRAL AMERICA.
See also Vol. I: CENTRAL AMERICANS.

PANAMA CANAL, *see* Vol. IV: PANAMA CANAL.

PARAGUAY. This is one of the two inland republics of South America, the other being BOLIVIA (q.v.) (*see* Map, p. 415). Paraguay, however, is connected with the sea by the River Paraguay. This river is navigable by sea-going ships as far as Asunçon, the capital, and after joining the River Parana, runs into the great River Plate estuary and thus to the Atlantic Ocean.

There are just under $1\frac{1}{2}$ million Paraguayans, most of them living in Old Paraguay which lies between the Paraguay and Parana Rivers to the east. Here, a range of flat-topped and thickly

A NATIVE VILLAGE IN THE PARAGUAYAN FOREST
Royal Geographical Society

forested hills runs north and south, and between the hills lie wide valleys with brick-red soil, covered by rich grass, and sometimes swampy with palm-fringed, shallow lakes. This district was first farmed by Jesuit missionaries who planted orange groves and first used the plant 'yerba' to make the Paraguayan tea, *yerba maté*. Now, maize, rice, and vegetables, as well as oranges and grapefruit, are grown.

West of the Paraguay River are level plains of black earth and sand, called the *chaco*. The lower and wetter land makes rich pasture, and large cattle-farms are growing up. Cotton and sugar-cane are cultivated. On the higher parts grow the quebracho trees, which provide a hard, heavy timber good for building. The quebracho logs are too heavy to float, and so have to be carried down the river on rafts of cedar.

Asunçon, the capital of Paraguay, is on the east bank of the River Paraguay, standing on a sandy plain overlooking the river. It was founded in 1536 by the Spaniards, and many of its houses are of Spanish-Moorish design, low and built round court-yards. It is the only large town in the country and has a population of about 95,000 people. Paraguay is still a backward country. There is reported to be considerable mineral wealth of iron, manganese, copper, kaolin (china clay), and oil, but so far these have been little developed.

See also South America.
See also Vol. I: Paraguayans.

PARALLAX, *see* Astronomy, Modern, Section 2.

PARICUTIN VOLCANO. At Paricutin scientists have been able to watch for the first time a volcano being born, growing to maturity, and then dying. In February 1943, as an Indian peasant called Dionisio Pulido was ploughing his field about 2 miles outside the village of Paricutin in Mexico, he noticed that the soil was hot against the soles of his bare feet. Later, his son said he heard noises under the ground, and white smoke began to come first from a small hole and then from between the furrows. In about an hour's time hot rocks and dense clouds of dust and smoke were being ejected from a hole about 30 feet deep and there was a loud rumbling noise.

By the next morning there was a volcanic cone 25 feet high. In a week this cone was 550 feet high, in ten weeks 1,100 feet, and in six months it was 1,500 feet high. The village of Paricutin, from which the new volcano took its name, was soon overwhelmed by vast quantities of sand, lava, ashes, cinders, and dust. The country was ruined for at least [illegible] miles round Paricutin, and dust and ashes were showered as far as Mexico City, 200 miles away.

After about $2\frac{1}{2}$ years the eruption of ash had ceased, but Paricutin was still continuously active, pouring lava from one or other of its vents. Then, on March 4th 1952, it stopped altogether, as suddenly as it had begun.

See also Volcanoes; Mexico.

PARIS. On the River Seine, 120 miles from the sea, lies the great city of Paris, capital of France. Situated in the midst of the Paris Basin, a lowland of great fertility, Paris is easily accessible from all parts of the country—the chief factor in the rise of the city. Paris is a busy inland port on the river and canal system which serves northern France, and is the terminus of road, rail, and air routes converging from every direction. It has a population of nearly three millions.

At the time of the Roman invasion of Gaul in the first century B.C., Paris was nothing more than a fishing village on the little island of the Seine which is now called the Île de la Cité. Its Roman name was Lutetia, and it was here that Julius Caesar received the surrender of the rulers of Gaul. Under Roman rule, Paris grew into a city, spreading to the mainland north and south of the island. The ruins of a Roman palace can still be seen near the left bank of the Seine.

As the centuries passed, buildings covered the hills of Montmartre and Montparnasse; and by the middle of the 19th century Paris was bounded by a fortified wall over 20 miles in circumference. This was necessary for defence owing to the unsettled state of France in the years following the French Revolution.

The Île de la Cité is the heart of Old Paris. It contains the famous Cathedral of Notre Dame. This was begun in the 12th century, and its exterior stonework is enriched with fine examples of medieval sculpture. The Pont Neuf (16th century), oldest of the city's thirty bridges, connects the Île with the mainland. The streets fronting the Seine are called *quais*, and those on

PARIS
Notre Dame is in the centre, on the Île de la Cité. In the foreground, on the left bank of the Seine, is part of the Latin Quarter. *Compagnie Aérienne Française*

the left bank are noted for the numerous bookstalls, shaded by trees, which line the river parapet. On the right bank, not far from the Île, lies a district of narrow streets and high ancient houses called the Marais, once the homes of the aristocracy of France, but now given over to neglect and decay. An occasional wall plaque recalls the former noble character of this quarter.

After the Revolution, the rebuilding of Paris was undertaken by Napoleon I. Strong fortifications rose up round the city, narrow crooked streets were swept away, and straight avenues and tree-lined boulevards were built. Public gardens, statues, and monuments, such as the Arc de Triomphe, embellished the new city. The principal architect was Baron Haussman. By 1871 Paris had been rebuilt—but it was again partly destroyed by German bombardment during the siege. To make matters worse, after the city's capitulation it fell into the hands of extremists who added to the destruction by burning many buildings including the Louvre Library and the famous Tuileries Palace. The city was soon rebuilt, however, and is to-day one of the most beautiful of European capitals.

In addition to its function as the administrative capital of France, Paris is also the centre of French art and culture. The most famous of the art galleries are the Louvre and the Luxembourg, both of which house priceless collections. The Sorbonne is the University of Paris. It is in the Latin Quarter where students have lived for many generations.

Paris is noted for luxury and gaiety. Her many theatres, cabarets, and restaurants are well known to visitors from all over the world. The Opera House is the largest in existence. The great shops on the boulevards are filled with luxury goods. The manufactures are chiefly luxury goods—motor-cars, jewellery, perfume, and clothing—and the city is famed as a centre of feminine fashions.

See also FRANCE.

PATAGONIA, *see* ARGENTINA.

PEARL, *see* Vol. II: PEARL OYSTER; Vol. VI: PEARL FISHING.

PEAT, *see* COAL; MOORLAND AND MARSH.

PEKING (PEIPING). Peking is above all a monument of the splendour and dignity of Chinese history. Before the Republic the city had been, at intervals for a thousand years, the seat of the Chinese emperors. GENGHIS KHAN, the Mongol, destroyed it in 1215; his grandson, KUBLA KHAN (qq.v. Vol. V), rebuilt it, and the succeeding dynasty, the Mings, made it the place we now know (*see* CHINESE CIVILIZATION, Vol. I).

Peking is in the far north-east of China, only just inside the GREAT WALL (q.v.). It seems strange that China was governed for so many centuries from such a remote point, but probably it was because Peking was in an ideal position from which to guard against the constant danger of invasion from the north. And then, when the Tartars and Manchus had successfully invaded and established themselves as the ruling power in China, they did not wish to go too far from their own homeland, and Peking remained the capital. When China became a republic, the new rulers chose for the capital NANKING (q.v.), which is nearer the great centres of population.

Peking is surrounded by 22 miles of towering walls, broken by sixteen gates at equal distances apart. Within the outer walls there is a plan of cities-within-cities, resembling a 'Chinese box', and showing the hand of one all-powerful planner. The innermost of these is the Emperor's palace, called the 'Purple Forbidden City', a vast expanse of range upon range of court-yards flanked by lofty pavilions. This is contained in a larger enclosure with walls 4 miles in length, filled with pleasure grounds, temples and lakes.

A STREET IN PEKING

While this magnificent palace is to-day but a museum show-piece, the life of the city is far from being extinct. Though of small commercial importance, Peking is still a vigorous centre of Chinese life. Its importance is cultural. Peking has long been the spiritual home of China's scholars, and up to the time of Japan's invasion it contained many of the principal schools, universities, learned institutions, and artistic centres of the country. To-day Peking may be a provincial city, but it is one with a history, cultural flavour, and architectural beauty which make it unique.

See also CHINA.

PENNSYLVANIA, U.S.A., *see* UNITED STATES OF AMERICA.

PERSIA (IRAN) is about seven times as large as Great Britain. Except for two stretches of coastal lowland, one along the Caspian Sea in the north and the other along the Persian Gulf and Indian Ocean, it is a huge arid and semi-arid plateau ranging from 2,000 to 6,000 feet above sea-level. High mountain chains border the plateau on all sides, shutting off Afghanistan and Baluchistan on the east, and the U.S.S.R. in the north (*see* Map, p. 17).

On the plateau the climate is dry and bracing. Summers are hot, but not unbearably so, and summer nights are cool. Parts of this plateau provide poor pasture for herds of camels, sheep, and goats kept by nomadic herdsmen. From these come the hair and wool for the carpet and rug industry—one of the most ancient and most important industries of the country. In the southern part there are vast areas of sand desert with moving dunes, while along the northern edge there are salt swamps fed from the Elburz Mountains, towering between them and the Caspian Sea. The most promising parts of the plateau agriculturally are in the north-west and on the borders of Afghanistan in the east. Grain, cotton, opium, tobacco, and vegetables are grown, as well as fruit-trees, such as pears, apples, quince, plums, apricots, and cherries.

The Elburz Mountains rise to about 12,000 feet in steep slopes thickly forested with lime,

PERSIA: A VIEW FROM THE ROCK OF ALAMUT
L. Lockhart

maple, elm, oak, beech, and box. The highest peak, Demavend, is over 18,000 feet. The Caspian coastal lowland is hot, wet, and steamy. In its swamps there is an abundance of game birds. Rice and maize are cultivated, and oranges, lemons, and limes are grown (*see* CASPIAN SEA). The coasts of the Persian Gulf and the Indian Ocean, though also very hot, are dry, and here maize, dates, oranges, lemons, melons, nuts, and pomegranates are grown. There are mines from which salt, sulphur, and red ochre are obtained.

A more recent source of wealth is the oil, worked mainly by the Anglo-Iranian Company and refined in the great refinery at Abadan. There are also deposits of coal, iron, copper, lead, nickel, and cobalt, but so far they have not been developed. TURQUOISE (q.v.), reputed to be the best in the world, is mined near Nishapur in the north-east. TEHERAN (q.v.), the capital, is in the north, on the south side of the Elburz Mountains. Isfahan, the capital in the 17th and 18th centuries, is nearer the centre of the country. Its tiled mosques and palaces, built in the 16th and 17th centuries, are world famous. It is difficult to make an exact estimate of the population of Persia, but there are probably about fourteen million people.

See also Vol. I: PERSIANS.

PERTH. Perth, the capital of Western Australia, has a population of about 300,000, and is situated on the Swan River about 10 miles from the sea, in the south-west of the continent. As the Swan is not navigable, the harbour is at Fremantle, on the sea; but the river near Perth widens out to provide an ideal setting for yachting and water sports generally, while the stretch of still blue water, with the great King's Park beside it, gives the city its special beauty.

Perth was founded by Captain Stirling in 1829, but its growth dates from the discoveries of gold in Western Australia in the 1890's. Though the great 'gold rush' disturbed the established way of life of Western Australia, it brought new energy and prosperity to the whole State.

The University of Western Australia, opened in 1913, is remarkable as the only university in the Empire to which admission is entirely free. This was made possible by a generous endowment from a wealthy newspaper proprietor. Suitable buildings were provided in one of the suburbs, and the university is now the most beautifully housed of any in Australia.

Western Australia is cut off by 2,000 miles of desert from the Eastern States, and the people of Perth form a separate little community of their own, cultured and leisurely, suspicious of the policies of the east, and in many ways looking more towards England than towards Sydney or Melbourne.

See also AUSTRALIA.

PERU. The Republic of Peru lies on the west coast of South America, just south of the Equator (*see* Map, p. 415). It stretches eastward from a Pacific coast some 1,400 miles long, across the Andes into the forests of the Amazon. The Spaniards began to colonize Peru in 1530, when Pizarro waged war against the INCAS (q.v. Vol. I), the Indian inhabitants of the land. In 1821 General San Martin led an army against the Spanish Viceroy, liberated his country, and became the first President of the Republic.

Peru has three very different regions: the

CUZCO, SOUTHERN PERU
The Cathedral was founded by Pizarro in 1534, after the sack of the Inca capital. *Margot Lubinski*

coastal lowland along the Pacific Ocean, the Andes mountain region, and the Montana lowlands in the east. The coastal lowland varies in width from 20 to 100 miles. This is a region where very little rain falls and, except for the river valleys, it is desert land. But as the main winds come from the sea and are cooled by the cold current which comes up the coast, heavy wet mists are a feature of the coastal lands. The river valleys are well-watered by streams fed from the snows of the Andes, and grow large crops of cotton and sugar-cane in irrigated fields. The Andes rise in steep, gullied slopes from the coastal plain, reaching heights of over 20,000 feet with peaks snow-capped all the year. At about 10,000 feet above sea-level there are plateau areas of wide, rock-strewn slopes, sometimes known as *punas*. These extend in the south into Bolivia in the Lake Titicaca region. On the plateaux and in river valleys, wheat, maize, barley, rice, and potatoes are grown, and occasionally pine-apples and bananas. The Montana region slopes down from the high, well-drained, upper Andes ,where coffee, cacao, bananas, and pine-apples are grown, to the flat tropical forests of the Amazon basin, with its riches of timber, nuts, and wild rubber.

Peru is rich in mineral wealth: silver, copper, and gold had been mined by the Incas for centuries before the arrival of the Spaniards, and Pizarro and his followers took much gold from the Indians. To-day Peru ranks third in the world's production of silver and provides four-fifths of the world's vanadium, a mineral used in steel-making. Copper is mined, and there are very productive petroleum fields. Perhaps the most interesting of Peru's sources of wealth are the deposits of guano left by generations of sea-birds on the islands along the shore. The sale of guano, a valuable fertilizer, is a government monopoly, and the government has received from this source more money than ever came out of the Inca mines. Cotton, sugar, rice, rubber, and medicinal plants are the principal agricultural exports of the country. Agricultural methods are often very primitive, especially among the Indians, who plough the ground lightly with rough wooden ploughs drawn by yoked oxen, scatter the seed broadcast, and cut the ripened grain by hand, threshing it either by treading it out by oxen or beating it with flails.

In the Peruvian Andes, llamas and alpacas, animals distantly related to the camel, are found. The alpaca is reared for its fleece, the llama used as a beast of burden. These animals have never been found wild, and must have been produced by intensive breeding from their wild relatives, the huanaco and the vicuna (*see* LLAMA, Vol. II). Communications across the mountains are so difficult, and good roads and railways so few, that much of the day-to-day transport depends upon the sure-footed llama and upon mules. One of the railways of Peru connects Callao, the most important sea-port, to LIMA (q.v.), the capital, and runs on to Oroya in the mining district. It is claimed to be the highest standard-gauge railway in the world. Another railway connects the old Inca capital, Cuzco, high up in the Andes, with the coast. Cuzco has many remains of the Inca civilization, as well as beautiful Spanish buildings—notably a cathedral built by the Spaniards in the 16th and 17th centuries.

See also AMAZON; SOUTH AMERICA.

See also Vol. I: PERU, ANCIENT CIVILIZATION; PERUVIANS.

TROLEUM, *see* OIL, NATURAL.

ILIPPINE ISLANDS. The 7,000 or so ls of the Philippines lie in the Pacific Ocean -east of Borneo, and form the eastern dary of the China Sea. Most of the islands but rocks and reefs, only some 450 being one square mile in area. The largest island, on, almost 41,000 square miles, lies near the th of the group, and the second largest, ndanao, about 37,000 square miles, lies hest south (*see* Map, p. 87). The Philippines very mountainous and are volcanic in origin. ere are still several active volcanoes, and mild thquake shocks occur quite frequently.

Many of the islands are covered with rich ests which produce valuable timbers, such as k, ebony, and sandalwood. From the forests come bamboos, rubber, bark for tanning, ra, and coco-nut oil, all of which are exrted. Where land has been cleared for farm-g, the soil is very fertile. Sugar has now taken place of tobacco as the principal product of islands. Some gold is found in Luzon, and ficient iron and coal are mined to meet home quirements. It is natural that fishing should an important industry, as the seas between e islands are very rich in fish. The coasts proluce a great variety of shell fish, and there is lso valuable PEARL FISHING (q.v. Vol. VI).

The Philippines were named after Philip II of Spain, for they became part of the Spanish Empire during his reign, and remained so until after the Spanish-American war at the end of the 19th century. Then they, as well as Cuba, passed to America. Since 1935 they have had a considerable degree of independence, though America still holds certain powers relating to foreign affairs and commerce.

The people of the islands, the Filipinos, are a mixture of POLYNESIAN and MALAY (qq.v. Vol. I). They are on the whole an agricultural people, taking life easily and not willing to farm very intensively. They love festivities and show, and their favourite entertainments are COCK FIGHTING (q.v. Vol. IX) and gambling. About 90% of them profess Christianity, the rest being Buddhists or Moslems, or following pagan beliefs. Most Filipinos now speak English, and some Spanish is still spoken. Of the native languages, Tagalog has been encouraged by the Americans, and the Visaya tongue is spoken in Mindanao.

Manila, the capital of the Philippines, stands on the west coast of Luzon and possesses one of the largest land-locked harbours in the Pacific. Old Manila is a walled Spanish city with a fine 16th-century cathedral; but the new town is an up-to-date American city with big business houses and warehouses. Throughout the islands most of the people live in villages in houses built of bamboo and with bamboo furniture. In some areas in Luzon the houses are built high above the ground on poles, and are entered by ladders which can be drawn up for safety against enemies. The total population of the Philippines is over nineteen millions.

NATIVE HOUSES IN MINDANAO, PHILIPPINE ISLANDS
Margot Lubinski

See also EAST INDIES.

PITCAIRN ISLAND. This is a South Sea island of volcanic origin, the most southern of the group known as the Tuamotu (or Paumotu) Islands, some of which are volcanic and some coral (*see* Map, p. 323). Pitcairn is British. Like most PACIFIC ISLANDS (q.v.), it grows coco-nut palms, tropical fruits, and shrubs. Fish abound in the lagoons round the islands.

This island is famous because it was settled in 1789 by the mutineers of H.M.S. *Bounty*. After

having cast adrift their commander, Bligh, and some of the men, the mutineers sailed to Tahiti. Then they went on to the uninhabited island of Pitcairn, taking with them Tahitian women, and there they settled.

PITCH, *see* Asphalt.

PLANETS. **1.** This word comes from the Greek *planetes* or wanderers and came to be used because, while the stars appear to swing in fixed circles round the Earth, the Planets seem to wander about the heavens in quite a different way. This is because they, like the Earth (which is really a planet also), travel in orbits or paths round the Sun. Another way in which the Planets differ from the visible stars is in being too cool to give off any light of their own: we see them only by the light of the Sun which they reflect. Also, while the Planets are so comparatively near to us that their distances can be reckoned in millions of miles, even the nearest star (excepting our own Sun) is at a distance so immense that a quite different scale of measurement has to be used (*see* Astronomical Measurements).

It has been suggested that the planets were originally part of the Sun, but that they were torn off by the gravitational pull of some great star passing close by, and left revolving round the parent body. If this theory is correct (and there are serious objections to it), it seems unlikely that such an accident can have happened to create systems of planets around many, if any, other stars. Then, when we examine the planets of our own solar system, it seems highly doubtful that human life can exist on any but the Earth—and so there are grounds for believing that mankind may be unique in the universe. Among the many things needed to maintain human life are a moderate range of temperature, an atmosphere that can be breathed, a reasonable proportion of water-surface to dry land, and, possibly, the recurring changes of day and night, summer and winter.

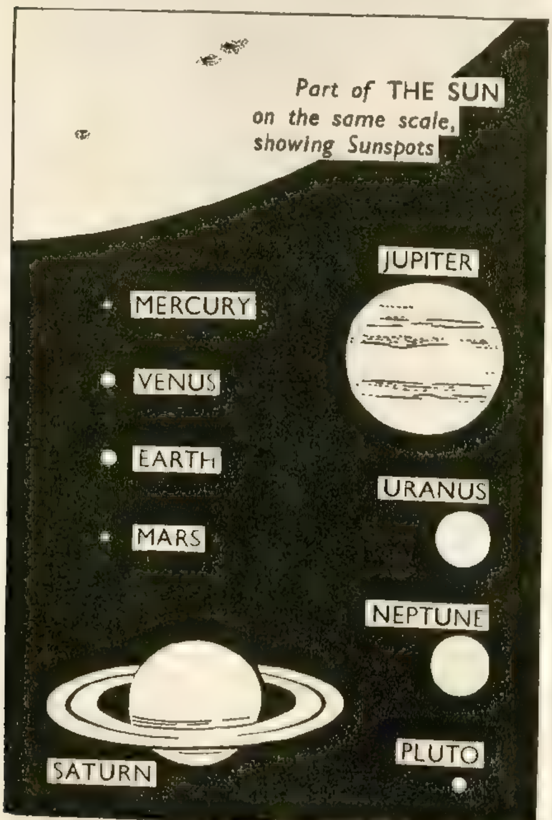


Fig. 1. The relative sizes of the planets
The exact size of Pluto is not known

Table of the Planets

Planet	*Mass compared with Earth's*	*Radius compared with Earth's*	*Diameter of orbit compared with Earth's*	*'Year' compared with Earth's*	*Time of rotation in Earth's 'days'*
Mercury	0·04	0·63	0·4	0·25	88
Venus .	0·9	0·9	0·72	0·62	225
The Earth	1	1	1	1	1
Mars .	0·1	0·5	1·5	1·8	1·1
Asteroids	..	..	..	..	..
Jupiter .	317	11	5·2	12	0·4
Saturn .	95	9	9·5	29·5	0·4
Uranus .	14·5	4	19	84	0·45
Neptune	17	4	30	165	0·7
Pluto .	(?)	0·5	39·5	248	(?)

In the Table above, the Mass (q.v.) of the Earth (5,876 million million million tons), its radius (4,000 miles) and the radius of its orbit round the Sun (93 million miles) are taken as units for comparison with other planets. Or, to form a very rough picture in our minds, we may imagine the Sun to be a ball 2 feet in diameter. The planet called Mercury is, then, like a grain of mustard seed 164 feet away, moving on a nearly circular orbit with the Sun at the centre. Venus would be like a pea, 284 feet away, and the Earth like another pea, 430 feet away. Mars would be like a pin-head 654 feet away. Jupiter, the largest, would be like an orange at a distance

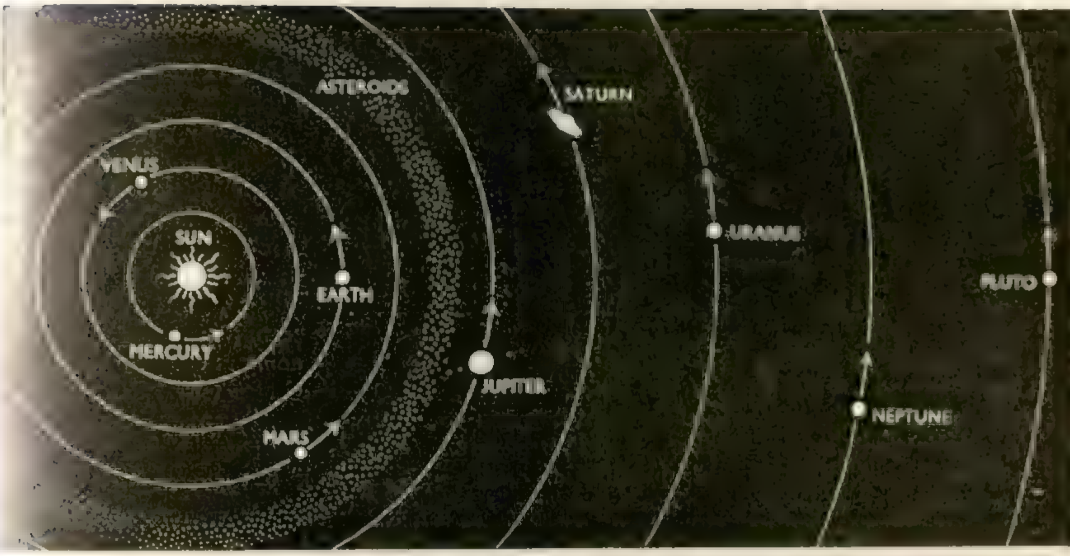


FIG. 2. THE ORBITS OF THE PLANETS IN THE SOLAR SYSTEM
This diagram is not drawn to scale. The orbits of the Planets are elliptic and some are eccentric

half a mile, whilst Saturn would resemble a smaller orange, four-fifths of a mile away. Uranus would be about the size of a plum 1½ miles away, and Neptune like a larger plum 2½ miles away. Finally, we should have to include in our picture Pluto, as a small body about 3⅓ miles away. Viewed from above the Earth's North Pole, these bodies would be seen to perform their orbits (which are all very nearly in the same plane as the Sun's equator) in a counter-clockwise direction round the Sun, with speeds changing gradually from Mercury's one revolution in a quarter of a year to Pluto's revolution in 248 years. On this same scale, the nearest STAR (q.v.) would be some 16,000 miles away. So space is not very crowded after all! (*See* Figs 1 and 2.)

Our very exact knowledge of the planets' movements is owed to the great astronomer KEPLER (q.v. Vol. V) (1571–1630) who worked out the Laws of Planetary Motion. He found that the orbits of all the planets, including the Earth, are not true circles but 'ellipses'. An ellipse is an oval figure with two centres; the closer the centres, the more circular is the ellipse. The elliptical paths followed by the planets are very nearly circles, and the Sun is at one of the two centres. Secondly, Kepler found that the planets do not move at exactly the same speed all the way round their orbits: they travel fastest over the part nearest to the Sun and slowest when farthest away. And thirdly, he found that the relation between a planet's distance from the Sun and its 'year' (or the time it takes to complete one circuit) is the same for all the planets. Some idea of the way in which astronomers make use of the knowledge of these laws is given in ASTRONOMY, MEASUREMENTS OF.

Let us now look at the planets individually and in more detail, starting nearest the Sun, with Mercury.

2. MERCURY. This is not an easy planet to see on account of its nearness to the dazzling light of the Sun. There are no very clear markings on its surface; but it seems as if, like the Moon to the Earth, it shows the same face to the Sun all the time, so that it has continuous daylight and intense heat on one side, and continuous dark and intense cold on the other. It has no atmosphere—we know this because the spectroscope shows no change in the composition of the sunlight reflected from its surface (*see* COLOUR), and also because there is no luminous 'halo' (as is seen with Venus) when the planet passes very near to the edge of the Sun.

3. VENUS. This, the Evening Star, being the nearest, is the brightest of all the planets—that lovely light of the morning or evening sky known from time immemorial. Of all the planets, only Mercury and Venus go through the complete cycle of 'phases' like the Moon (*see* ASTRONOMY, MODERN), and those of Venus are the more

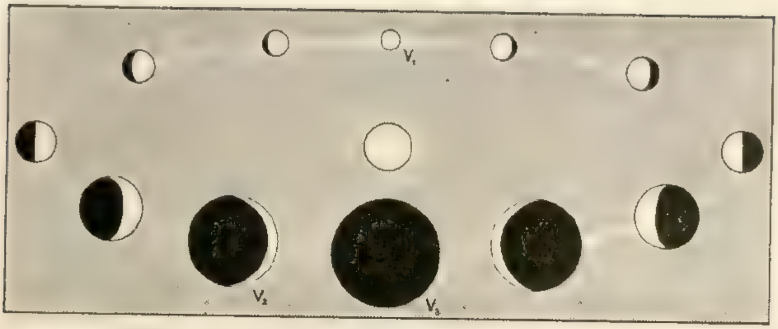


FIG. 3. THE PHASES OF VENUS

striking. Fig. 3 shows that when Venus is 'full', at V_1, it is much farther from us than when it has a crescent shape, at, say, V_2. Thus at V_1 the apparent radius of Venus is about one-fifth of what it is at V_3; and it becomes interesting to see whether the increase in apparent radius makes up for the decrease of the illuminated part we see. The fact is that Venus appears brightest at about 36 days before and after passing V_3 (a position known as 'inferior conjunction').

It was GALILEO (q.v. Vol. V) who first saw all these phases by means of his new telescope—and the fact that Venus shows a complete set can, as he realized, be used as a strong argument for believing that the Sun is the centre of the solar system, and not the Earth (*see* ASTRONOMY, HISTORY OF). The absence of clear markings makes it difficult to know the time of rotation of Venus—especially since this planet seems to have a cloud-covered atmosphere, composed mainly of carbon dioxide. The probable temperature of the bright side is 55° C. and of the dark side about minus 20° C.

4. EARTH. This planet is described in a separate article. All planets nearer the Sun than the Earth—that is, Mercury and Venus—are called 'inferior'. Those farther from the Sun are called 'superior'. These superior planets are said to be at 'opposition' when the Earth is between them and the Sun. They are then well placed for observation, though, when opposition occurs in summer, they are low in the sky and cannot be observed so well.

5. MARS. This planet, whose name comes from the Greek god of war, is notable for its 'ruddy' colour. From early days the markings on its surface have given rise to much speculation. There are polar caps, probably of ice, which show large seasonal changes, like those of the Earth. There are large areas of a brownish-orange colour and other patches of greenish-grey—which it is tempting to think of as dry land and sea, though the 'sea' does not reflect the sunlight quite as we should expect water to do. Then there are the famous 'canals', first noted in 1877, which are said to look like 'straight' (i.e. great circle) lines intersecting each other and darkening in colour as the polar caps melt. One would be tempted to think of these as the result of intelligent efforts to irrigate desert land, were they not also found in parts which look like seas. But not all observers can see them, and they do not show up in photographs; so there is much doubt if they exist at all—and (as someone has pointed out) it is strange that 'intelligent' beings should make canals to carry water from the north polar regions to the southern hemisphere and vice versa, and that water should flow along straight paths rather than according to the contours. The atmosphere of Mars appears to be about

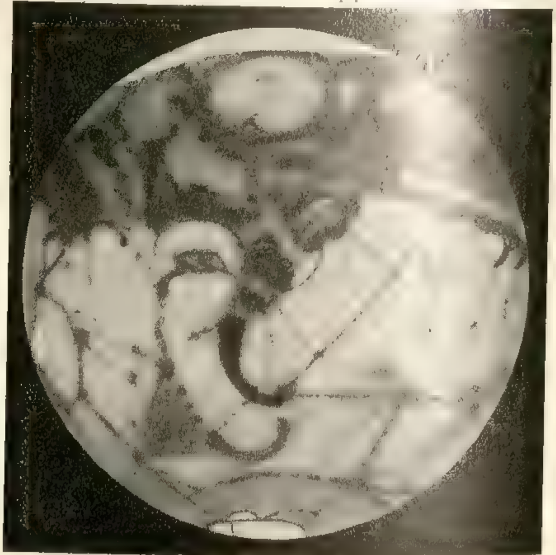


FIG. 4. A MAP OF MARS
The Polar caps and Syrtis Major (shaped like an elephant's trunk) can be seen through a small telescope. The fainter lines are the 'canals'

50 miles deep, and judging by the small gravitational pull of the planet, it must be very rarefied. The temperature of the polar cap and of the dark side of the planet is about minus 80° C., whilst

the warm side may experience daily changes of as much as 100° C. Thus, if there is any life on the planet, it must be capable of withstanding conditions very different from those on Earth. Mars has two small moons, Deimos and Phobos.

6. The Asteroids or Minor Planets. The question, 'What planet comes next to Mars?' raises an interesting point. There has been age-long speculation concerning the relations between the distances of successive planets. Do they form a simple series of numbers? They appeared to—and in 1772 a series was suggested which worked very well, except that in one place there was a blank where there should have been a planet. After that it was always suspected that there might be an undiscovered planet filling the gap (which came between Mars and Jupiter). In 1801, a tiny body called 'Ceres' was found on this orbit, and since then over 1,000 others have been measured, some with diameters of less than 50 miles. These bodies are called 'The Asteroids', and, though the measurements do not allow us to say so with certainty, it is tempting to think that they are the remains of a planet which has broken up.

7. Jupiter. This is the largest and heaviest planet. A very small telescope will show at least four moons revolving round Jupiter—there are, in fact, eleven. The surface markings of the planet consist of coloured belts at right angles to the polar axis. The movement of these, and the bulge at the equator, suggest a very rapid spin—and a 'day' on Jupiter is, in fact, only about 10 hours long. The spectrum of the reflected light shows that the atmosphere contains a good deal of ammonia and methane; hydrogen and helium are thought to be present also. It is probable that the entire planet is gaseous (unless the high pressure at the centre has liquefied the gases there). It was Galileo who first saw these moons in 1610, and he was struck by the fact that here we have a tiny working model of a 'heliocentric', or sun-in-the-middle, system. It was the eclipses of Jupiter's moons which first enabled us to measure the speed of Light (q.v.).

8. Saturn. The famous 'rings' of Saturn are one of the most amazing sights that the telescope can show. They are distinctly divided into three, the outermost, with a diameter about two and a quarter times that of the planet, being divided from the middle one by a space. These two are as bright as the planet itself. The inner ring, which can only be seen through a powerful telescope, is called the Dusky or Crape Ring and

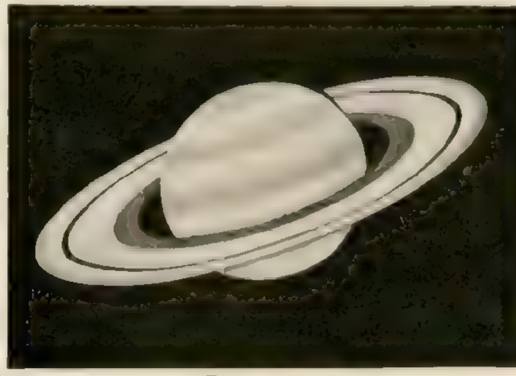


Fig. 5. saturn

has a dust-like texture different from the others, which have been found to consist of swarms of small bodies. The plane of the rings is so set to the path of the Sun that we see both sides of it alternately in periods of about fifteen years. The thickness of the rings is estimated at 50 miles—too thin for them to be visible when they are edge-on to the Earth. They do not revolve as one disk: the outer edge moves independently of the inner, and, under the influence of the planet's gravity, more slowly. Their origin is still a matter for speculation. In addition to the rings, Saturn possesses nine moons, the outermost of which revolves in an opposite direction to the others—a rare occurrence in the heavens.

9. Uranus. This planet was discovered in 1781 by William Herschel, an amateur astronomer who made his own telescope. At first it was thought to be a comet; but calculations of its orbit showed it to be a new planet. Uranus has four moons, and an atmosphere similar to Jupiter's. The temperature is about minus 200° C.

10. Neptune. This planet was 'discovered' by mathematical methods. Astronomers in 1834 and 1840 had worked on the idea that certain irregularities in the orbit of Uranus might be explained by the gravitational pull of a more distant planet yet to be discovered. In 1843, Leverrier in France, and J. C. Adams in England, working unknown to each other, both calculated just where this planet should be looked for. Unhappily for Adams, his finished calculations were temporarily overlooked by the then Astronomer Royal; but Leverrier's similar calculations were successfully used at the

Berlin observatory in 1846 to recognize Neptune as a planet for the first time, although it was not the first time the body had been seen.

11. PLUTO. The outermost planet in the solar system was discovered in 1930. It was found by comparisons of photographs of the 'fixed' stars, taken at a few days' interval, in an area where a new planet was supposed (on mathematical grounds again) to be. It is a small planet, but little further is yet known about it.

See also ASTRONOMY, MODERN; UNIVERSE; ECLIPSE.

PLATINUM, *see* METAL ORES.

PLUTO, *see* PLANETS, Section 11.

POLAND. During her long and troubled history, Poland has suffered many changes of frontier. After the First World War, when she became again an independent nation, her only exit to the sea was by the Polish Corridor, a narrow strip of land between Germany proper and East Prussia, reaching the Baltic Coast at the free city of Danzig. After the Second World War and the shifting of German population from East Prussia, the Corridor was done away with. Poland now possesses a large stretch of Baltic coast, and covers much the same area as in the first centuries of her existence—that is to say the lands drained by the two great rivers, the Oder and the Vistula (*see* Map, p. 160).

Except for the Carpathian Mountains and the plateau along their western edge, Poland is part of the Great European Plain. The soil of the plain is mainly sandy and requires careful cultivation to yield good crops. Rye and potatoes are grown everywhere, and wheat, sugar-beet, hops, and tobacco in the more favoured localities. Poland used to consist of very large estates belonging to the aristocracy. Now these have been broken up. The small-holders usually breed pigs and grow fruit. There are many forests, mainly of spruce and Scots fir, but the forests are not usually large. The country is well watered, with many rivers and small lakes, and in some places fish, mostly carp, are bred on a large scale. Poland used to be very rich in game and also in poultry. Hares and pheasants were exported to Germany, partridges and turkeys to France, and eggs to the United Kingdom.

Though the plain may appear monotonous to those who cross it in a railway train, it is in reality full of charm, and has, with its broad horizons, a quiet spaciousness which is impressive. Wherever there is a patch of rising ground there is usually a village church, surrounded by a ring of fine old limes or poplars—and a double row of lime-trees as an avenue to the manor house in which the local landowner lives, or at one time lived. The villages generally consist of a long line of white- or blue-washed cottages, often with their gardens, pigsties, and beehives facing them across the road.

South-east of the great plain there is a plateau of rich land, which, especially in the foot-hills of the Carpathian Mountains, produces beautiful scenery. Wheat, sugar-beet, and flax are the chief crops and, in the east, large numbers of horses are reared. The CARPATHIANS (q.v.), which run along the frontiers of Czechoslovakia and Roumania, are high, steep, and forested. There is magnificent scenery, especially in the High Tatra region, where many people go for winter sports and summer climbing. The two great rivers, the Vistula and Oder, both have their sources in the Carpathians.

Though predominantly agricultural, Poland has important industries as well. Some of these are connected with agriculture—as, for instance, bacon-curing, the extraction of sugar from beet, and the distillation of potato-spirit. Others are of independent growth. In the district of Lódź, to the west of Warsaw, cotton and woollen goods and artificial silk are produced in very large quantities. Bialystok, in the north-east of the country, manufactures textiles, mainly blankets; while Bielsko, in the extreme south-west, produces very fine broadcloths. Częstochowa, as well as its famous monastery which is a place of pilgrimage for Poles from all parts, has important jute factories. A considerable metallurgical industry has arisen near the deposits of iron-ore near Kielce. The Polish Government has done much to develop industry in this part of Poland by harnessing some of the water-power provided by the innumerable torrents rushing down from the Carpathians. The great dam at Roznów was just approaching completion in September 1939. Coal, mainly in the great Silesian coal-fields, is the only mineral wealth, apart from rock-salt, which Poland possesses in quantity. Silesia also has zinc-mines. Almost all the former Polish oil district lies east of the new frontier between Poland and the Soviet Union.

POLAND: THE LITTLE TOWN OF GNIEW ON THE VISTULA
E.N.A.

The Vistula has always been the main artery of Poland. The old capital of Cracow and the new capital of WARSAW (q.v.) are situated on it; and Poland's natural port, Danzig, is at its mouth. When in spate, the Vistula carries down enormous quantities of sand, and is apt in consequence to shift its main channel from side to side of the broad bed within which it flows. Between Warsaw and the sea there are many thriving towns on the banks of the Vistula, some of them, for instance, Torún, the birthplace of COPERNICUS (q.v. Vol. V), of considerable size and of great antiquity and beauty.

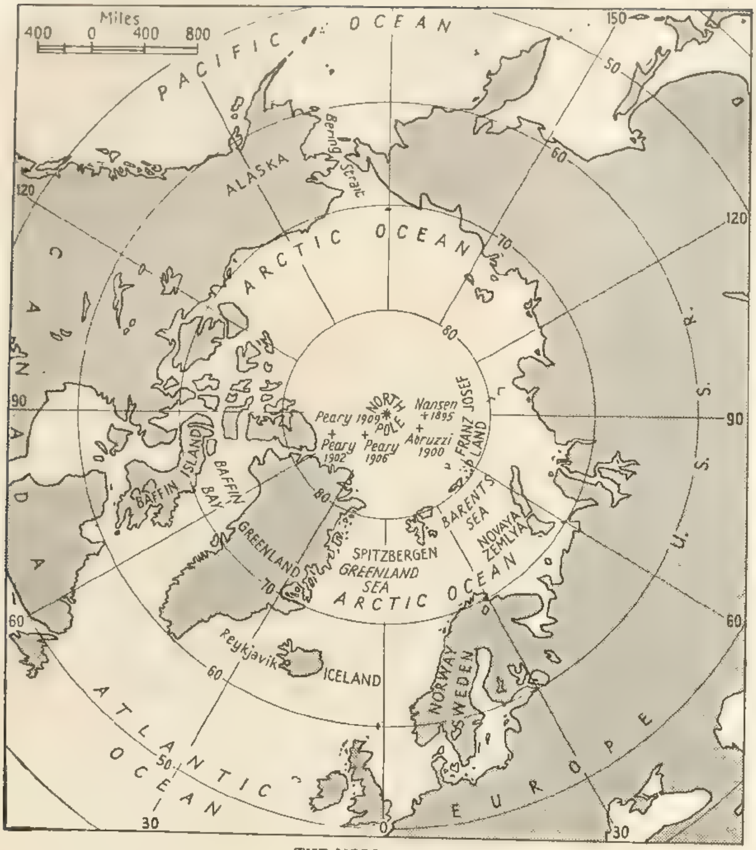
Danzig and Warsaw suffered great destruction in the Second World War. Danzig, one of the finest towns in northern Europe, was built for the most part with the wealth which its merchants gained from the flow of trade passing through the port and up the Vistula. Warsaw, in the main, was a town of the 19th century, which had been skilfully laid out about 1820 by clever Italian architects. Poznań, in the west, suffered considerably in the war; but, fortunately, Cracow, perhaps the most beautiful Polish city, emerged with most of its fine buildings intact.

See also Vol. I: POLES.

POLARIZATION, *see* LIGHT.

POLAR REGIONS. **1.** These are, strictly speaking, those parts of the earth's surface that lie between the Arctic Circle and the North Pole, and between the Antarctic Circle and the South Pole; but these definitions must be modified when conditions of climate and vegetation are considered. North Polar or Arctic regions go far south of the Arctic Circle in Canada, and stop far north of it in Europe. Arctic regions may be defined as lands with a long cold winter, a short summer, with no tree growth, and with their seas congested all the year round with floating ice. No part of Europe is included because strong currents from the Atlantic cause a gulf of relative warmth on the European side. In the Antarctic, with its much more severe climate and little summer, the limit of the polar regions is about latitude 60° S. which is roughly the northern limit of floating pack-ice. Icebergs, however, float farther north to less cold climates and seas.

2. ARCTIC REGIONS. Arctic and Antarctic regions differ widely in characteristics. The North Pole lies in the Arctic Sea, an extensive ice-covered sea that is probably never open



THE NORTH POLE

enough for a ship to navigate. This sea is surrounded by a ring of islands between which are channels, the widest of these being the Greenland Sea, between Greenland and Spitsbergen. Next in width, but much narrower, is Bering Strait, between Asia and North America; and thirdly comes Smith Sound, between the Canadian Arctic Islands and Greenland. Pack-ice, formed in the Arctic Sea, is driven out through these channels to the Atlantic and, to a much less extent, to the Pacific Ocean. Conversely, a certain amount of relatively warm water flows into the Arctic Sea. Of the Arctic lands, Greenland alone has a huge ice-cap; but Ellesmere Island, Baffin Island, parts of Spitsbergen, and most of the islands of Franz Josef Land have small ones. From these caps Glaciers flow outward and shed Icebergs (qq.v.) into the sea.

All Arctic regions at sea-level have low winter temperatures, but at least three months of summer with occasional warm days. Snow falls in winter, but generally melts in summer at low altitudes. No Arctic land, except where it is covered in ice, is devoid of vegetation. On low ground there are many bright flowers in July and August. Pasture in most lands is enough to support musk-oxen and reindeer. There are also foxes, changing from brown in summer to blue and white in winter, polar bears, wolves, ermines, seals, walrus, narwhals, and great quantities of fish and other lowly creatures in the sea. Many sea-birds—gulls, petrels, and others—come north to nest in summer; but there are few birds in winter. The only human beings native to Arctic lands are the Eskimos (q.v. Vol. I) of Arctic Canada and Greenland; but there are few Arctic lands that now have no European or Canadian population, such as the traders of the Hudson's Bay Co., the Danes in Greenland, and the Norwegians and Russians in the coal-mines of Spitsbergen. There are also weather observatories in many Arctic lands, which help in making the Weather Forecasts (q.v.) for the British Isles and elsewhere. Between them, Norway, Denmark, the Soviet Union, and Canada claim all the Arctic lands.

3. The Antarctic Regions are occupied mainly by Antarctica, a continent of 5 million square miles, or about one and a half times the area of Europe, in the heart of which lies the South Pole. Almost the whole continent is covered with a sheet of ice several thousand feet in thickness. Gradually by its own weight this ice-sheet, made from consolidated snow, slips outward and breaks off into the sea in huge icebergs that may be anything from some hundreds of yards to 50 miles in length. This ice-sheet is a complete desert, broken only by some lofty ranges of bare rock. Nothing whatever, plant or animal, lives on it: there can be no land animals in the Antarctic because there is no food for them.

THE SOUTH POLE

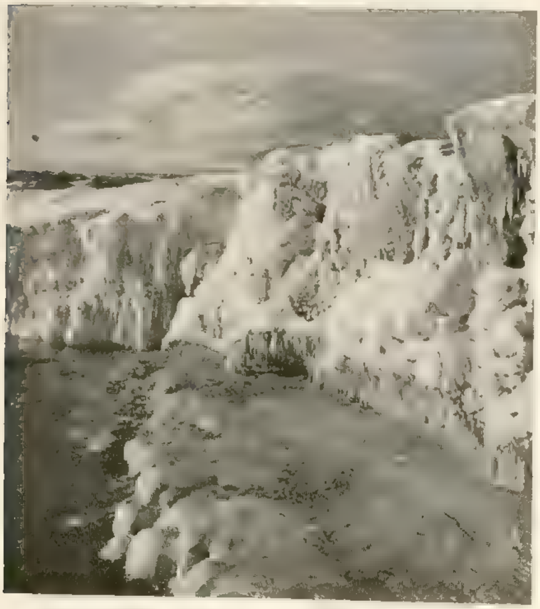
The Antarctic is always cold except on a few calm, sunny days about midsummer—and even in summer, temperatures above freezing-point are rare. In the long winter, temperatures may fall to over 100° of frost. Very strong Antarctic winds, blowing from the dense air masses on the plateau, carry snow before them, causing terrible blizzards. There is never any rain. No plants, except a few mosses and lichens, grow in the far south, and there is no soil. In summer a few rocky beaches and crags between the ice cliffs of the great ice-sheet are bare of snow for a few weeks, and become the nesting place of sea-birds, such as petrels, gulls, terns, and—above all—penguins. In summer penguins are everywhere round the coast and on every rocky islet in vast noisy rookeries, many of which include several million birds. Various small penguins are most numerous and most noisy, and they all leave for the open sea in autumn. The rare and lonely Emperor Penguin, seldom seen except in pairs, nests in the middle of the winter and never leaves the Antarctic. Several kinds of seal are very numerous, because the Antarctic seas, like those of the Arctic, abound with fish, shrimps, and other marine animals on which seals, penguins, and petrels flourish. The valuable fur-seal has been practically exterminated. Whales are numerous in the sea around Antarctica (the Antarctic or Southern Seas); but only the valueless grampus or killer whale, a small, fierce animal, goes in among the pack-ice. The large whales provide the only commercial product to be found in Antarctic Seas. Whaling stations have been established on several islands; but large factory ships are generally used as floating stations where the whales are cut up and boiled for oil, preserved for whale-meat, or ground down for manure (*see* Whaling, Vol. VI). The prospects of whaling led to various states claiming sovereignty of Antarctic lands—Great Britain, U.S.A., Norway, Australia, and the Argentine. But the lands will probably never be of continued interest to anyone but scientific explorers.

See also Aleutian Islands; Greenland; Iceland; Polar Regions (Exploration).

POLAR REGIONS (EXPLORATION).
1. Conditions of Polar Travel. The chief difficulty in exploring Polar Regions is one of transport. In the winter, sometimes even in the summer, sea-ice forms, and this ice drifts to and fro with wind and current; while huge masses of land-ice (that is, consolidated snow) are shed by glaciers into the sea and endanger ships. Polar ice is generally hard enough to cut open a ship; while a ship caught among ice driving before a strong wind is easily crushed. In early days, when all vessels were propelled by sail alone, the danger was greater than it became when auxiliary steam was added about the middle of the 19th century. Modern full-powered steam-

vessels are even safer. The keels of polar vessels are generally made rounded so that the vessel will lift between driving ice-floes and so escape fatal pressure. The distribution of ice governs the course of the exploring vessel. The Antarctic continent is girdled by a broad obstructing belt of heavy ice, though now and then and here and there are gaps or weak places. In the Arctic, obstruction by ice is most likely in winter, for summers are warmer and new ice seldom forms, even though the old ice may only partially melt. Aircraft are overcoming many of the difficulties of finding a passage and are now being largely used in the Arctic.

To most people polar exploration suggests great cold and exposure. It is true that polar temperatures are low in winter—in the Antarctic they are low in summer also. The Arctic, however, has several really warm weeks in summer, and most of the winter polar temperatures are no lower than those of eastern Canada —and are actually higher than those of inhabited Siberia. To young and healthy people cold is no great hardship. It must be remembered that the explorer is generally well fed, adequately clothed, and takes plenty of exercise. Furthermore, the air is generally dry. Of course, low temperatures with strong winds are very unpleasant, and may be dangerous; but frostbite can generally be avoided if care is taken.



THE ICICLED CLIFF EDGE OF A GLACIER IN ANTARCTICA, WITH MOUNT EREBUS IN THE DISTANCE. *Paul Popper*

Snow-blindness is a common inconvenience due to straining of the eyes in sunshine and in mist. It is painful and slow to cure, but can be avoided by wearing suitable glasses.

Until the end of last century the terror of the polar explorer was scurvy. Nearly all explorers were affected, often with fatal results. It is now known that scurvy is due to the absence of certain vitamins found in fresh food and so is caused by a diet of preserved food. If the old explorers had been content, like the modern ones or the Eskimoes, to live on seal, reindeer, bear, fish, and birds, they would have escaped all risk of scurvy. The germ-free atmosphere ensures that no colds or fevers occur. Probably the greatest difficulty that faces the polar explorer is the polar night, varying from one twenty-four hour period at the polar circles to six months at the Pole. Gloom and darkness are depressing but not fatal, and nowadays the explorer is hard at work all the winter. Polar life and travel prove fascinating to most who have tried them, and there is no call whatever to regard the polar explorer as a hero.

2. The North Pole. Arctic explorations began in the 16th century with the early attempts to find short cuts to the East over the 'top of the world'—the long dreamed of North-West and North-East Passages. These are referred to under Exploration in Vol. IV. Here we are concerned with the attainment of the North Pole—not so much for scientific or practical reasons as for pride in overcoming difficulties. Various routes, each using a land in high latitudes as a base for sledging north, were tried and failed. F. Nansen's plan of 1893 was the boldest. It entailed drifting ice-bound in his ship, the *Fram*, with a transpolar current. When far north, Nansen (q.v. Vol. V) and one companion left the ship, sledged north to latitude 86° 14′ N., a world record, and then back to Franz Josef Land. R. E. Peary (q.v. Vol. V), after several attempts from Greenland, sledged from Grant Land to the Pole in 1909. Since then the Pole has frequently been reached by air.

Arctic exploration in recent years has turned on the whole to more scientific ends in the detailed exploration of various areas; and aircraft have often been used for transport. A notable series of journeys covering many years (1906–18) was made in the Canadian Arctic Islands by V. Stefansson, who showed that the explorer, like the Eskimo, can live and

thrive on local products of fish, birds, and game. Much Danish and English exploration has been done in Greenland, Norwegian work in Spitsbergen, and Soviet work in Franz Josef Land. One of the more daring and fruitful expeditions was the Soviet North Pole Expedition under Papanin in 1937–8. Four men were flown from Franz Josef Land to the North Pole, where they set up a camp and observatory and drifted south for nine months. They were then picked up in the Greenland Sea by a Soviet icebreaker which had got in touch with them by radio. Their observations were of the greatest value in filling many gaps in our knowledge of Arctic weather and ocean depths and currents. In the inter-war years much useful work was done in Arctic regions by small summer expeditions (or occasionally longer ones), chiefly from Oxford and Cambridge, each expedition concentrating on a small area.

3. THE SOUTH POLE. The early exploration of the Antarctic regions, which began in the 18th century, is referred to under EXPLORATION in Vol. IV, since its object was not so much to reach the South Pole itself as to find out conditions round it. The first attempt to get to the Pole was made by SHACKLETON (q.v. Vol. V) in 1908–9. He reached latitude 88° 23′ S.—about 160 miles from the Pole. A few years later the Norwegian AMUNDSEN (q.v. Vol. V) travelled with dog-sledges, reaching the South Pole on 14 December 1911. A month later, on 17 January 1912, Captain SCOTT (q.v. Vol. V) also reached the Pole. Exhausted by the heavy work of sledging, hampered by very bad weather, and weakened by lack of food, the whole party of five, Scott, Wilson, Oates, Bowers, and Evans, perished almost within sight of safety, their bodies and letters being found later by a search party. Most Antarctic flying has been done by Americans, R. E. Byrd in 1929 being the first to fly over the South Pole (*see also* Colour Plate opp. p. 352).

See also Vol. IV: EXPLORATION.

POLE STAR, *see* ASTRONOMY, MODERN, Section 2.

POLYNESIA, *see* PACIFIC ISLANDS; *see also* Vol. I: POLYNESIANS.

PORTUGAL. Two-thirds of the Iberian Peninsula is composed of a high, ancient plateau called the Meseta. Eastern Portugal is part of the Meseta and is a region of high cliffs and

PORTUGAL: A TRIBUTARY OF THE DOURO
The steep hill-sides are cultivated in terraces
Casa de Portugal

deep gorges. The three great rivers, the Douro, the Tagus, and the Guadiana, cut very deep gorges on their way to the sea. From its southern coast-line Portugal stretches north for 300 miles in an almost perfect rectangle 100 miles wide (*see* Map, p. 160). Portugal's position on the trade-wind route to America and her nearness to the Mediterranean, helped her to gain an empire. This empire, however, has been lost because the population of the home country was not large enough to provide settlers for it.

The northern half of the country is mountainous and rugged, except for a narrow coastal plain. The coastal plain is usually flat and sandy. Southern Portugal—that is, Portugal south of the Tagus—is mainly rolling plateaux and plains covered with pasture land. There is little rain, and in summer the rivers almost disappear. The winters are cold. Except in the south, where the climate is sub-tropical and cane-sugar and rice are grown, the rainfall is not great enough to make agriculture on a large scale possible without irrigation, and this is just beginning to be used. However, a considerable amount of oats, rye, wheat, olives, maize, and barley are grown for home use, and there are

great areas of vineyards. The Douro valley produces the best and most famous Portuguese wine—port, named after Oporto—a most important export. Fish, timber, and fruit are also sent abroad from Oporto and Lisbon.

Portugal has a good deal of mineral wealth; but the hard rock of the mountains has made it difficult to build roads and railways, so that there has been little industrial development. The people nearly all work on the land. Portugal remained independent when Spain was overrun in turn by GOTHS, VANDALS, and MOORS (q.v. Vol. I), and the isolation of centuries has made the Portuguese a proud and conservative race, reluctant to adopt new methods.

LISBON (q.v.), the capital, with a population of 709,000, is situated on the estuary of the Tagus. It has a fine harbour and is the port for the fertile plain of Estremadura. It has recently become important as a port for Transatlantic air-routes. The only other large town is Oporto, the Douro wine port, which has also a flourishing textile industry.

See also Vol. I: PORTUGUESE.

PRAGUE was formerly the capi[illegible] the kingdom of Bohemia and is now th[illegible]tal of the republic of Czechoslovakia. Th[illegible]es on the River Vltava, a tributary of t[illegible]. With over a million inhabitants, it is th[illegible]ncial and manufacturing centre of Czecho[illegible]. Above all, however, it is interesting f[illegible] beautiful baroque architecture of a large [illegible]e centre of the city. Prague first grew t[illegible]tance in the 14th century under the Emp[illegible]harles IV —in fact the boundaries of the t[illegible] laid out were not exceeded until the [illegible] century. During his reign, the Charles U[illegible], one of the oldest in Europe, was found[illegible] the most active building period—the ba[illegible] period—was in the 18th century, under th[illegible]trians.

The *Malá Strana*, or Small [illegible] on the west bank of the river, consists al[illegible]tirely of old palaces (now mostly used [illegible]vernment offices), churches, and narrow [illegible] streets with the pavements often running [illegible]r vaulted arches—all having the dignity [illegible] proportions of the best baroque style. [illegible] wander endlessly in this quarter, perp[illegible] finding fresh enchanting small streets, [illegible]uddenly

THE CHARLES BRIDGE AND THE MALÁ STRANA OF PRAGUE
In the background are the Hradčany Castle and the Cathedral of St. Vitus

coming on a large and dignified old palace or monastery. And surmounting it all, high up on the side of the valley, is the Hradčany Castle, a massive and imposing building of many periods, once the fortified palace of the Bohemian kings and now the residence of the President of the Republic. The Cathedral of St. Vitus is built right in the middle of the castle, where its spires appear unexpectedly between the roofs. On the other side of the river, across the famous Charles Bridge built by Charles IV in 1357, is the *Staré Město*, or Old Town. This part of Prague is not so delightfully unspoilt as the *Malá Strana*, but has many fine baroque churches and other buildings. In fact, baroque is so entirely the prevailing style in the central parts of the city that buildings, originally Romanesque or Gothic, were later overlaid with a baroque façade.

The *Nové Město*, or New Town, mostly built of dark-grey concrete, differs little from other noisy continental towns, with cobbled streets and trams running down the main streets.

The climate of Prague is the usual central European variety—very cold in winter, when the river, which is wide and shallow, freezes over entirely, and very hot and dry in summer. As the town lies in the river valley, it is liable to much fog and haze; but it is protected from the winds from which Bratislava, for instance, the capital of the province of Slovakia, often suffers. Just outside the city is the modern airport of Ruzyn, a centre for air communication all over Europe. Prague, in fact, both spiritually and geographically, is a meeting-place between eastern and western Europe.

See also Czechoslovakia.
See also Vol. XII: Baroque Art.

PRECESSION, *see* Earth; Astronomy, Modern, Section 4.

PRECIOUS STONES, *see* Agate; Amber; Amethyst; Aquamarine; Diamond; Emerald; Garnet; Jade; Jet; Lapis Lazuli; Meerschaum; Opal; Rock-crystal; Ruby; Sapphire; Topaz; Tourmaline; Turquoise; Zircon; Colour Plate opp. p. 288.

PREHISTORIC ANIMALS. Long before Man lived on the Earth there were fishes, reptiles, birds, insects, and some mammals. Although some of these animals were ancestors of kinds living to-day, others are now extinct, that is, they have no descendants alive now. Nevertheless, we know a great deal about many of them because their skeletons and shells have been preserved in the rocks as Fossils (q.v.). From them we can tell their size and shape, how

A DINOSAUR'S SKULL
The fossil as it was found in the Gobi Desert
American Museum of Natural History

they walked, the kind of food they ate. Very occasionally the rocks show impressions of skin, so that, apart from colour, we can build up a reasonably accurate picture of an animal that died millions of years ago. The kind of rock in which the remains are found tells us much about the nature of the original land, often of the plants that grew on it, and even of its climate (*see* Earth, History of).

When an animal dies the body, its bones, or shell, may often be carried away by streams into lakes or the sea and there get covered up by mud. If the animal lived in the sea its body would probably sink and be covered with mud. More and more mud and silt would fall upon it until the bones or shell became embedded and preserved. Nearly all of the fossils that we know were preserved in rocks formed by water action, and most of these are of animals that lived in or near water. Thus it follows that there must be many kinds of mammals, birds, and insects of which we know nothing.

The earliest animals whose remains have been found were all very simple kinds and lived in the sea. Later forms are more complex, and among these are the crinoids or sea-lilies, relations of the star-fishes, which had long arms and were attached by a long stalk to the sea bed, or to rocks, or even to floating things. There were also crab-like creatures, the trilobites, whose

PREHISTORIC ANIMALS: AN IMAGINARY PICTURE OF ENGLAND 120 MILLION YEARS AGO

In the foreground is Iguanodon, and an armoured dinosaur (Polacanthus) to the right. Behind is the [illegible]atic Titanosauros and a Pterodactyl is flying above. The luxurious vegetation includes conifers, tree ferns, and horsetails.

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bodies were covered with a horny substance. The body segments each had two pairs of legs, one pair for walking on the sandy bottom, the other for swimming. The head was a kind of shield with a pair of compound eyes, often with thousands of lenses. The trilobites were usually an inch or two long but some were 2 feet.

The shell-fish have a long history in the rocks and many different kinds are known. Of these, the ammonites are very interesting and important. They have a shell composed of many chambers, each representing a temporary home of the animal. As the mollusc grew larger it grew a new chamber and sealed off the previous one. Some ammonites left trumpet-shaped shells, but most of them lived in coiled shells. Thousands of these can be seen in the rocks on the Dorset Coast.

The first animals with true backbones were the fishes, first known in the rocks of about 375 million years ago. About 300 million years ago the amphibians appeared. They looked like giant salamanders, sometimes 8 feet long, and many of them lived in the swampy pools in which our coal seams were formed. The amphibians gave rise to the reptiles and for nearly 150 million years these were the principal forms of life on land, in the sea, and in the air.

The plesiosaurs were marine and had barrel-shaped bodies with the four legs forming paddles to propel them through the water; several grew to a length of 30 feet. Living at the same time were the ichthyosaurs ('fish-reptiles'), with long-snouted heads and fish-shaped bodies. The plesiosaurs laid eggs but the ichthyosaurs had the young born alive. Both were fish eaters.

While these reptiles were roaming the seas, the pterodactyls were gliding overhead. They had wings of skin stretching from a finger bone, along the side of the body to the hind legs and tail. Many were no larger than a sparrow but others, whose remains are known from the chalk of Kent in England and from Kansas, U.S.A., had a wing span of 20 feet.

On land this was the Age of Dinosaurs, several kinds of which are the largest of any land animals we know. One group were flesh eaters and preyed on the others. The English megalosaurus was of this kind. It ran on its hind legs, the long tail acting as a balance, and it used its front legs only in resting and in feeding. Megalosaurus measured from 10 to 20 feet, from snout to tail. The head was a foot long and the teeth an inch or two high. The American tyrannosaurus was about 50 feet long, with a head 4 feet in length whose teeth stood 4 inches above the gums. These dinosaurs had claws on fore and hind feet and must have been fierce creatures.

The plant-eating dinosaurs on which they

By courtesy of Mrs. Wilson

ANTARCTICA: HUT POINT AND MOUNT EREBUS

Water-colour by Dr. E. A. Wilson, one of the members of the Scott Expedition, 1911–12

preyed, were of different kinds. The great quadrupeds, like brontosaurus, with small heads on very long necks, large bodies, and very long tails, were often more than 60 feet long and lived in the waters of the lakes. Living near the lake borders were bipedal dinosaurs such as iguanodon. Other kinds of dinosaurs, also plant eaters, but which walked on all-fours, were armoured with bony spikes and plates.

About 75 million years ago the Age of Reptiles was over and most of the groups died out. The mammals quickly developed, and we can trace the evolution of many familiar animals such as the elephant and the horse. Many of the later mammals, though now extinct, were known to primitive man and were featured by him in cave paintings and on bone carvings.

See also Vol. I: Evolution of Man; Prehistoric Man. See also Vol. II: Evolution.

PRESSURE. Everyone knows the meaning of this word, but most of us think of it usually in connexion with solid objects—the pressure of our feet on the floor or the pressure against our shoulders in a rugger scrum: the pressure of fluids (i.e. of liquids or gases) is a much less familiar thought, though it may cross our mind when we hear on the wireless that 'a ridge of high pressure is approaching the British Isles' or when we blow up a bicycle tire. There is one great difference between solid and fluid pressure: a solid transmits pressure in one direction only; but in a fluid the pressure is the same in every direction. It is as well for us that this is so, because the pressure of the atmosphere above us is about 14 lb. per square inch—and if we had to bear the weight of this on our heads and shoulders it would crush us to the ground. As it is, the same pressure acts upwards from below, inwards from all sides, and outwards from inside, so that we do not notice it at all.

The fact that there is a weight of air above us, or 'atmospheric pressure' as it is usually called, was discovered as lately as the 17th century by an Italian named Torricelli. He was led to the discovery by puzzling over a fact which had baffled men ever since Roman times—that no pump could suck up water from a greater depth than 32 feet. Torricelli decided that this might be because the pressure of the air was just equal to the weight of a column of water of that height. He saw that he could test his theory by taking a much heavier liquid than water—if he was right, the air would not be able to support nearly so long a column of that. Accordingly, he filled with mercury a glass tube closed at one end and stood it on the open end in a bowl of mercury (Fig. 1). It was as he thought—the mercury dropped in the tube until it stood about 30 inches above the level of the bowl. In other words, the atmospheric pressure was equal to 30 inches of mercury or 32 feet of water. Soon afterwards, Pascal (q.v. Vol. V), the great French thinker, took Torricelli's tube up a high mountain and found, as he had expected, that the atmospheric pressure grew less, and the mercury sank lower, the higher he climbed.

Fig. 1. TORRICELLI'S TUBE
The pressure of mercury at B is equal to that of the air at A

It was discovered that atmospheric pressure did not stay exactly the same from day to day, even at the same level, and that falls generally meant bad weather while rises generally meant good. To-day we still make use of Torricelli's tube in some barometers—though the aneroid barometer, which measures the atmospheric pressure in a different way (*see* Barometer, Vol. VIII), is now more common. (In this the air presses more or less heavily on a flat metal box from which the air has been sucked out, squeezing its sides in or allowing them to spring outwards again, their movement being then linked up to the indicator hand.) We should remember that, although barometers are sometimes called weather-glasses and marked 'Rain', 'Change', 'Fair', and so on, they are really no more than instruments for measuring the pressure of the atmosphere. To make the most accurate weather-forecasts possible, many other things besides atmospheric pressure have to be taken into account (*see* Weather Forecasting).

When we suck lemonade up through a straw, what we really do is to lower the pressure inside the straw, and then the pressure of the atmosphere upon the surface of the lemonade in the glass forces the liquid up the straw. Even when we breathe, we merely lower the pressure in our lungs so that the air can force itself in from outside. When divers go down to great depths in

the sea or airmen fly at great heights, they must take time when returning to ordinary levels for the pressure inside their bodies to get back to normal. If they neglect to do this, they may suffer from nose bleeding or from agonizing pains called 'bends'.

It was Pascal who discovered that pressure in fluids (liquids and gases) acts equally in all directions. But there is one respect in which liquids under pressure differ from gases: a gas can be very easily squeezed or compressed so that it occupies less space; but a liquid is for most practical purposes incompressible (liquids can be very slightly compressed under very high pressure indeed). As a result of the research by the Englishman Robert Boyle in the 17th century, and, later, of the Frenchman Charles, these principles of the behaviour of gases were established: (1) If the temperature remains unchanged, an increase of pressure is accompanied by a proportional decrease of volume, or vice versa; (2) If the temperature rises or falls, then either the pressure or volume or both will increase or decrease. For instance, if we beat air into a pudding and then put the pudding into a hot oven, thus changing its temperature, the volume of the air will expand, and the pudding will rise. Again, VOLCANOES (q.v.) erupt when the rising temperature of the gases inside increases the pressure so much that they burst through the Earth's crust. Other examples of the way these principles work in the natural world are given in CLOUDS and THUNDERSTORMS (qq.v.).

See also WEATHER FORECASTING.

PRUSSIA, *see* GERMANY.

PUNJAB, *see* INDIA.

PYRENEES. For 250 miles, between the Bay of Biscay and the Gulf of Lions, the Pyrenees form the frontier between France and Spain (*see* Map, p. 160). Their average height is 5,000 feet above sea-level and the highest point is the Pic d'Aneto (11,168 feet) on the Spanish side. As they are only 60 miles wide, the passes through them are very steep.

The core of this mountain rampart is formed of old hard rocks such as granite; but younger sandstones and limestones cover the slopes. Everywhere there is evidence of past and present ice action, and Gavarnie is famous for the waterfalls tumbling over the cliff edge of its steep limestone walls from the snowfield above. Unlike the Alps, there are no large glaciers, but there are several small ones.

On the French side the Pyrenees rise up steeply from the plain; but on the Spanish side they rise more gradually, their ridges extending into the Ebro valley. The French Pyrenees are characterized by deep, narrow valleys, at the lower ends of which, where the rivers leave the mountains, small historic towns have grown up. These towns, many of them religious centres or fortresses, are linked by a roadway, the famous Route des Pyrénées, which is popular with tourists in summer when the snows have melted.

The contrast in climate and scenery between the French and Spanish slopes of the Pyrenees is very marked. The southern slopes are dry and barren, with few trees and little cultivation. On the northern side, where the rainfall is much heavier, most of the slopes are wooded and the valleys cultivated. There is a great difference, too, between the eastern and western ends of the range.

Although the Pyrenees have always been a formidable barrier, travellers have been able to by-pass them by the coastal corridors, which are followed to-day by the railways. There are many rough tracks over the mountains, but they are little known except by French and Spanish shepherds and smugglers. Recently, two electric railways have been constructed—one tunnel leading under the Sompart Pass and connecting Pau with Jaca and Saragossa, the other following the Col de Puymorens and connecting Toulouse with Barcelona.

The Pyrenees fall into three divisions. The Western Pyrenees lie west of the Sompart Pass and include the Basque country, which is cut in two by the frontier. By far the lowest part, with a cool climate and abundant rain, they are suitable for agriculture and stock-raising. The people cling to their own language and customs, and physically are quite distinct. The coastal region from Bilbao to Bayonne is very picturesque, St. Jean-de-Luz, Biarritz, and San Sebastian (the Spanish summer capital) being noted holiday resorts. Farther inland, the streams on the French side are used for generating electric power. A motor-road runs over the Pass of Roncesvalles to Pamplona, the capital of Navarra. In the mountain valleys old customs die hard. Each year on 13 July, for example,

AN ISOLATED PASS IN THE CENTRAL PYRENEES. *Paul Popper*

the people in the French valley of Barétous pay a tribute of three cows to the people of the Spanish valley of Roncal—they have done this every year since 1375, in token of some wrong committed at that time.

The Central Pyrenees, which stretch some 160 miles eastwards from the Sompart Pass to the Col de Puymorens, have magnificent scenery. Their isolated mountain valleys long preserved their independence; and in one of them the tiny state of Andorra still has its own laws and general council, though it owes formal allegiance to both France and Spain. The pastoral life of high mountains recognizes no boundaries—and migrating flocks of sheep cross and re-cross the frontier. In Andorra, as in the Basque country to the west, there is much smuggling. At the foot of the mountains on the French side is Lourdes, a centre for pilgrims who visit its limestone grotto and miraculous spring. Many of the French towns have small woollen, leather, and paper industries. Iron-smelting is carried on and hydro-electric power is being developed.

The Eastern Pyrenees, which are lower than the central part, stretch from the Col de Puymorens to the coast, steep white limestone cliffs overlooking forests of cork-oak, olive groves, and vineyards. The fortress of Perpignan, centre of the productive region of Roussillon, guards the routeway between France and Spain.

In spite of their differences, the three regions of the Pyrenees have much in common—in fact the peoples of the mountains, whether French or Spanish, have more in common with each other than with those of their own countrymen living in the plains below.

See also MOUNTAIN BUILDING; FRANCE; SPAIN.

Q

QUAGMIRES, *see* MOORLAND AND MARSH.

QUANTUM THEORY. Everything in the world, whether solid, liquid, or gas, is made up of atoms, and every atom, of whatever substance, is made up of very much smaller 'elementary particles'. The existence of these particles has only been discovered during the present century, so that it is not surprising that we do not yet know very much about them. We know to a considerable extent what they do; but no one yet has any real idea what they are (*see* ATOM). For centuries scientists disagreed as to whether light, heat, and other forms of radiation are made up of minute particles (as was believed by the ancient Greeks and, in the 17th century, by Newton) or of tiny waves—as scientists came to believe in the 19th century. To-day the particle theory is generally accepted as true; but because certain properties of radiation can only be explained as being due to waves, it is believed that the particles themselves share the nature of waves to some extent (*see* LIGHT and RADIATION). The position, then, is that both matter itself and radiation are believed to consist of particles.

The quantum theory deals with the action of these particles upon each other. Although it is by no means yet perfect and complete, it is certainly on the right lines. *Quantum* is a Latin word meaning 'a definite amount', and the main statement in the quantum theory is that action can take place only in definite amounts. (The word 'action' is used by scientists in rather a special way to mean energy or work combined with time—and all radiation is, of course, a form of energy.)

It had always been supposed that action could happen in any amount, great or small; but in 1900, Planck, who had been investigating the radiation of heat, announced that there was a certain smallest possible amount of heat radiation below which no action could take place. Furthermore, he found that action could take place only in whole-number multiples of the amount (never including fractions). The definite amount of radiation needed for action was called the quantum. Five years later, Einstein broadened the idea to include light radiation (the quantum of which he called a 'photon'). He showed also that radiation, as well as being sent out in separate 'packets' or 'shocks' of one size, could not even exist in smaller amounts. In other words, if there is not enough radiation to make up one quantum, there cannot be any at all.

In 1913 the theory was extended to cover the behaviour of the particles in atoms, and they were found to follow exactly the same rules. At that time the particles composing the atom were thought to be arranged as a heavy central 'nucleus' with lighter particles circulating on fixed orbits round it, rather like the planets round our own sun. But as more came to be known about the behaviour of these particles, especially when they were thrown out of the atom, it became clear that all the evidence pointing to the wave-like character of radiation particles applied with equal truth to them. The dividing line between matter and radiation had become very thin—and the quantum laws applied equally on either side of it.

Physicists soon realized that the quantum theory upset the classical ideas of MECHANICS (q.v. Vol. VIII), which is concerned with the action of force on matter. In mechanics it is assumed that any moving particle must be in a particular place and must have a definite speed and direction through space at any particular moment. In the case of particles as tiny as those which make up the atom, or those used for bombarding the atom, this is no longer true, because they are so small as to be affected by the tiny quantum when we try to observe them. If we leave them in the dark, we cannot watch them at all; but if we shine a light on them, their speed and direction are changed, because light, like all radiation, exerts a slight pressure. Light consists of particles, and we 'see' the particle under observation because a light particle has been reflected back from it. In other words there has been a collision which is bound to have affected the course of the particle we are

trying to watch so carefully. The shorter the wave-length of the light—i.e. the bluer the light—the larger its quantum (*see* RADIATION) and the more violent is the collision: but if we try to weaken the collision by using a light of longer wave-length—i.e. a redder light—we find that the waves are now too long to be reflected from the particle at all. Again, if we use light of suitable wave-length and try to reduce the number of collisions by cutting down its brightness we find we have now less than one photon (i.e. quantum) so that no action is possible, and therefore we see nothing.

It might be thought that some method of observation other than light would help; but this is not so. Any method, whether electrical or mechanical, has the same results, because all matter, as well as all radiation, is composed of particles similar to the ones we are trying to observe.

The result is that if we want to know exactly the position of such particles, we can do so only by spoiling our chance of observing their speed, or if we want to know their speed we must give up hope of finding their position accurately.

Since 1925 a new form of the quantum theory has developed. It is called 'wave mechanics', because it is chiefly concerned with the wave-like behaviour of particles. In 1927 Heisenberg published the 'uncertainty principle', which states that the impossibility of finding out the position and speed of any one particle is a fundamental law of nature, and not merely the result of technical difficulties. It goes farther, and maintains that the behaviour of any one particle is not only unknowable, but is, in fact, quite uncertain: all we can ever hope to know is the amount of 'probability' that it will be in a certain place or moving in a certain way at a certain time. Wave mechanics, then, pictures particles no longer as tiny bodies which can be definitely located in place and time, but rather as wave-patterns of varying electric charges, the pattern being densest where the probability is greatest (*see* Fig. 1). By means of immensely difficult calculations, in which the principles of RELATIVITY (q.v.) play an increasingly important part, the wave-patterns can be worked out mathematically for any particular circumstances.

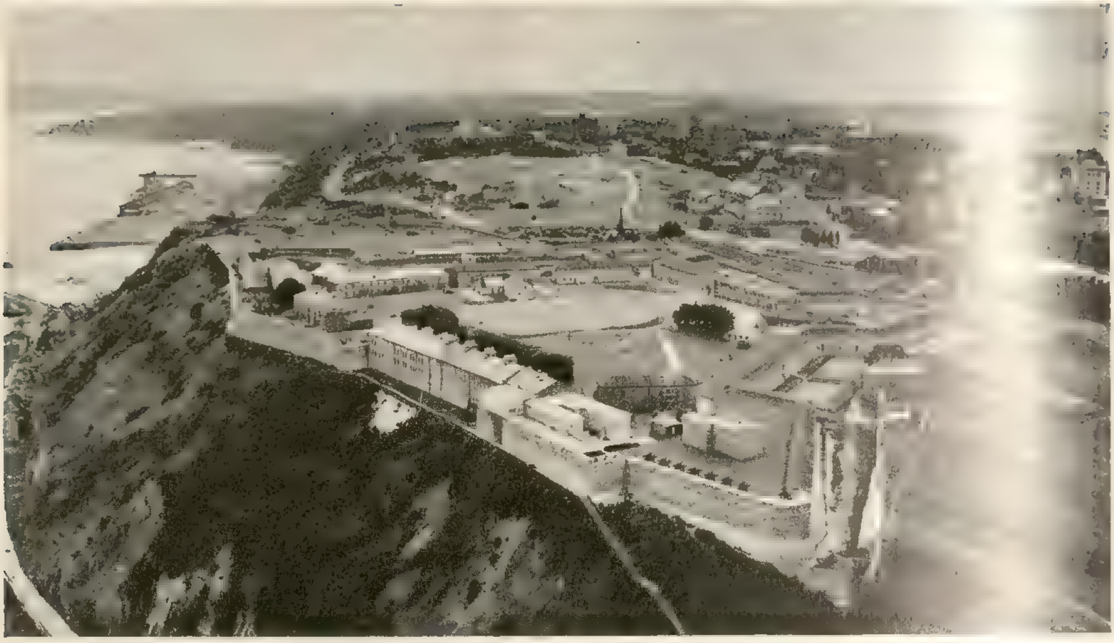
Probability may seem a most unscientific thing on which to depend for results; but, after all, insurance companies have long made use of it. When they accept insurances for the lives of 10,000 men aged 30, they know almost to a year when those men will die. They know almost to a man how many of them will reach the age of 60—although whether Mr. Jones will live to be an old man or not they neither know nor care,

FIG. 1. DIAGRAM SHOWING SOME OF THE DIFFERENT WAVE-PATTERNS OF THE ELECTRIC CHARGES IN ATOMS

for they are interested not in individuals but in the group as a whole. Similarly, wave mechanics does not attempt to follow the doings of an individual particle: it tries to view the group as a whole. If the scientist's calculations tell him that millions of particles will 'probably' behave in a certain way, he can be reasonably sure (though never quite certain) that enough of them will do so to produce the effect he has calculated. Whether wave mechanics will ever take on a simpler form which can be understood by the ordinary man seems doubtful; but it will, before long, affect the course of his life very directly, as the use of atomic power is developed.

QUARTZ, *see* MINERALS, Section 2.

QUEBEC. This, the most historic and picturesque city in Canada and capital of the province of Quebec, is mainly French-speaking, the English population being relatively small. Quebec is one of the great ports of Canada, connected to the Atlantic by the lower ST. LAWRENCE RIVER (q.v.), which seldom freezes. It is the capital of French Canada and the centre of important timber and pulp industries. The city consists of Lower Quebec, built on flat land by the river, where the poorer people live in narrow streets in the shadow of its many churches, and Upper Quebec, high above, where the well-to-do people have always lived. The two are connected by streets which wind perilously up the cliffs. Upper Quebec contains most of the fine buildings, such as the Parliament Buildings and the Château Frontenac, an hotel built in the style of a French castle. The Monument to Champlain, the city's real founder, is there, and the English Cathedral. Higher still, on the summit of the famous Rock



THE CITADEL AND THE PLAINS OF ABRAHAM, QUEBEC CITY
R.C.A.F. Photo

of Quebec, is the Citadel, the official residence of the Lieutenant-Governor. Beyond the Citadel are the Plains of Abraham (named after a river pilot, Abraham Martin), where the famous battle was fought which decided whether Canada was to be French or British, and where now stands a monument to WOLFE (q.v. Vol. V) and Montcalm, the generals who commanded the English and French armies on that occasion.

Quebec is the only city in North America, except for New Orleans, in which old and new live side by side. It is quite usual to see both horse-drawn buggies and stream-lined cars in the crowded streets. Many of its inhabitants, particularly of Lower Quebec, seem to belong more to the 18th century than to the 20th. On the Island of Orleans, in the St. Lawrence River, just downstream from the city, oxen still draw the ploughs, and women weave their own cloth, as they did several centuries ago.

See also CANADA.

QUEENSLAND, *see* AUSTRALIA.

QUICKSANDS. ('Quick' is here used in its old sense of 'living'—as in 'the quick and the dead'.) These are areas of sand which look very much like the safe sand round them, but which actually contain so much water that any heavy object placed upon them is engulfed. Quicksands are not uncommon round our coasts, though there are few large enough to be really dangerous. They occur most often near the mouths of large rivers. In most cases their presence is due to a bowl-shaped underlayer of clay or other rock through which the water is unable to soak away. In certain places, however, they result from the agitation produced by strong currents or tides, being then always near the water and often quicksands only at certain states of the tide.

If a human being is caught in a quicksand, he sinks in and may well be drowned. The rate at which he sinks is hastened by his struggles, since every effort to pull one leg out only pushes the other deeper into the sand. If he were to make no struggles at all, it seems probable that his head would remain above the surface, because sand and water must obviously be denser than water alone, and the buoyancy of the human body should therefore be sufficient to keep at least the nose and mouth in the air. Certainly anyone trapped should stop struggling the moment he is convinced that he cannot get free, and should confine his efforts to shouting or signalling for help.

R

RADIATION. The forms of radiation most familiar to us are LIGHT and HEAT (qq.v.). These reach us in the form of waves, moving at a speed of 186,000 miles per second and able to travel through space on their way from the Sun to the Earth. Their 'wave-length', or the distance from crest to crest of the waves, can be measured: if it is between approximately 0·0004 and 0·0007 of a millimetre, our eyes 'see' the radiation as light; if it is rather longer, we feel it as heat. But radiation can be conveyed on wave-lengths either longer or shorter than these—and the Table below shows the very different forms it then assumes.

Wave-length in millimetres	*Electro-magnetic Waves*	
0·000,000,000,04 (average)	COSMIC RAYS (q.v.). Emitted by some source outside the earth; able to penetrate through several yards of lead.	
0·000,000,002 (average)	Gamma rays. Emitted by radioactive substances, such as radium and uranium (*see* ATOM).	
0·000,000,1 (average)	X-rays (Röntgen rays). Used in medicine and industry for seeing or photographing through opaque objects.	
0·000,2	Ultra-violet rays. Invisible to the eye, but affecting photographic plates. Plentiful in sunlight and beneficial to the human body, in which they produce Vitamin D.	
0·000,4	Violet light.	Visible Light.
0·000,43	Indigo ,,	
0·000,45	Blue ,,	
0·000,5	Green ,,	
0·000,58	Yellow ,,	
0·000,62	Orange ,,	
0·000,72	Red ,,	
0·001	Infra-red rays. Heat. Penetrate fog better than visible light rays and are used for photography with special plates or films.	
0·2 mm. to 2,000 metres	Wireless (Hertzian) waves.	

The early study of radiation was chiefly that of light. For centuries there was discussion as to how light travelled: whether in the form of tiny particles, as the ancient Greeks believed, or in waves. We now believe that light and the other forms of electro-magnetic radiation consist of small packets of energy in the form of waves, and so share the character of both waves and particles.

The Electro-magnetic theory of Light was put forward by the famous physicist Clerk Maxwell in 1865. He formed it as a result of noticing how closely the problems of light resembled those of electricity and magnetism, on which he had been working. Not only did he suggest that light travelled in the form of electro-magnetic waves; but he foresaw the possibility of making electrical apparatus to send out similar waves of a different wave-length from those of light. This prophesy came true twenty-three years later, after his death, when Hertz discovered the first wireless waves (*see* WIRELESS TELEGRAPHY, HISTORY OF, Vol. IV). The article on LIGHT tells how 19th-century scientists were led to accept this theory because only wave motion could account for 'diffraction', 'interference' (*see* WAVE-MOTION), and 'polarization', and how they were then nonplussed by the failure of every attempt to find any 'ether', or wave-carrying medium in space—since waves of nothing seemed a clear impossibility.

The same puzzling result was reached by physicists who were inquiring into the nature of heat radiation. Experiments show that this obeys the same laws as light. It is transmitted in straight lines, and can pass through a vacuum; it can be reflected from a surface, and can be 'refracted' (or bent by such things as lenses) and so on. Heat radiation, then, it was decided, must be similar in character to light radiation. The Table of Wave-lengths was extended upwards and downwards, so as to include not only the visible light rays but also the invisible heat rays and, at the other end, the invisible ultra-violet rays. The wireless waves followed in 1888. These were much longer than any so far discovered; and it was not long before waves very much shorter than ultra-violet rays were found—X-rays, discovered by Röntgen in 1895. The addition in 1900 of gamma rays, from radioactive substances, and of cosmic rays, from outer space, in 1921, completed the list of electromagnetic radiations as we now know it.

But at about the beginning of the century a new discovery had been made which seemed to show that radiation could not be purely a result of wave-motion after all. It concerned a phenomenon called the 'photo-electric effect'. When certain forms of short-wave radiation are allowed to fall on thin layers of metals, such as silver or sodium, they have the effect of knocking off some of the tiny particles composing the atoms of the metals, so that they fly away at immense speeds. For instance, if an X-ray apparatus is pointed at a glass plate coated with a preparation of one of these metals, as soon as the X-rays are switched on, the plate begins to glow, although the rays themselves give out no visible light. (Incidentally, if we hold our hand in the beam, we can see its shadow and that of the bones inside it on the plate.) The glow is caused by the flight of the particles dislodged by radiation. Scientists can measure very exactly the amount of energy given to each particle to start it on its flight, and also the amount of energy falling on each atom on the screen as the rays strike it. But, very curiously indeed, the particle is always found to possess much more energy than any one atom could have received from its share of the rays. This could not be so if radiation were entirely conveyed by waves, since these would spread out evenly over the whole screen; but it could be so if the rays themselves were particles in which the energy was concentrated.

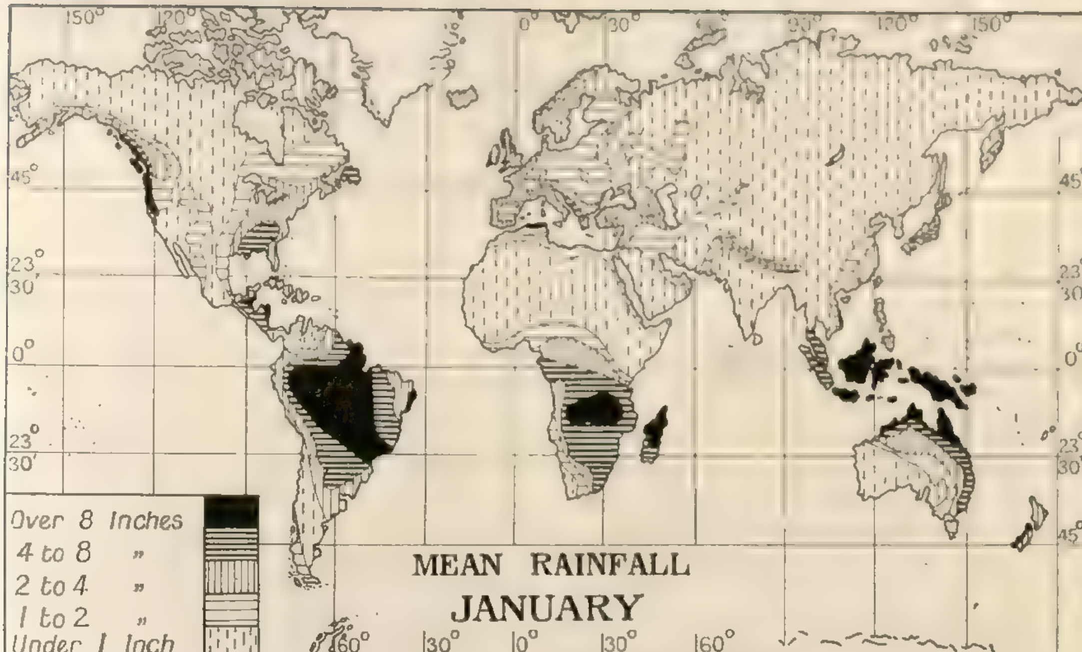
Meanwhile, the attempts to find a satisfactory theory for heat radiation were continuing. The first step into the unknown, the beginning of modern physics, was the publication by Planck in 1900 of his 'quantum theory'. In this he assumed that heat energy was not transmitted in continuous waves, but was sent out at intervals in small packets which he called 'quanta' (*quantum* being the Latin for 'a definite amount'). Five years later, EINSTEIN (q.v. Vol. V) made a similar assumption for light, the quantum of which he called a 'photon'. Soon the theory was extended to cover all radiation.

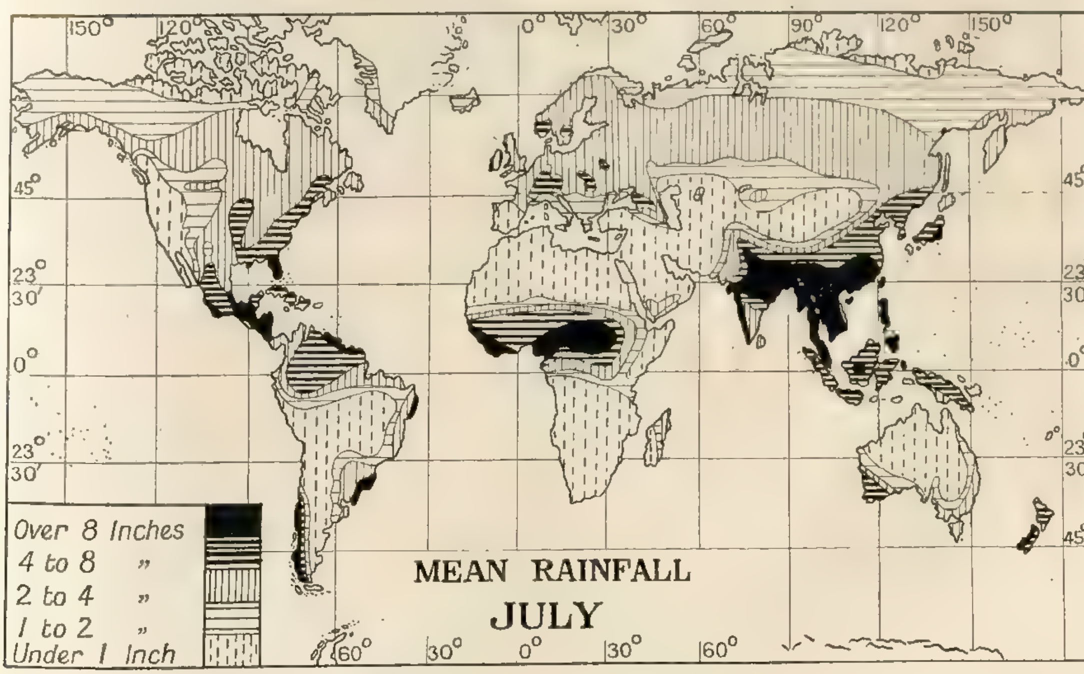
The amount of energy in a quantum of any kind of radiation was found to depend exactly on its 'frequency', or the number of waves sent out per second: it equals the frequency multiplied by a very small number, called 'Planck's constant' (because it remains the same for all waves). So the quantum of wireless radiation is comparatively small, because its frequency is small, its wave-length being long (*see* Table), whereas the amount of energy in the quantum of X-rays is enormously larger, because the frequency of its much shorter waves is so much greater.

The development of the theory in the new science of 'wave mechanics', which deals not only with radiation but with the wave-like particles of matter itself (for the dividing line has grown very thin) is described in the article on the QUANTUM THEORY (q.v.). Here we need only note that the conflict, which seemed so clear-cut, as to whether particles or waves compose radiation, has been abandoned. Wave mechanics deals—and deals successfully—with both aspects by purely mathematical methods.

RADIOACTIVITY, *see* ATOM.

RAIN. There is a limit to the amount of moisture or WATER-VAPOUR (q.v.) which air can contain, and this limit depends on the temperature, warm air being able to hold much more than cold air. The atmosphere is always loaded with moisture in varying amounts, its main source of supply being evaporation from the oceans. When a body of air is cooled in any way down to 'dew-point', its excess of moisture condenses into water on the tiny specks of dust almost always present, and becomes visible as cloud. These particles now tend to fall to the ground; but being very small (only about one-hundredth of an inch in diameter) they sink hardly faster than 8 feet or so in a minute. As each droplet loses height, it may reach warmer air nearer the ground—and its own temperature will in any case be raised by the increasing PRESSURE (q.v.) upon it; so it stands a very good chance of evaporating again. Or the current of air which originally carried the moist air upwards may be rising faster than the droplet is falling—in which case it will remain aloft. One of these two things happens to the particles in all fair-weather clouds. But if it is to turn to rain, the droplet must collide and join up with other droplets drifting about, thus growing bigger and heavier, and falling faster in consequence—with the result that it still further increases its chances of hitting other droplets. Finally it is so large and falls so fast that neither evaporation at lower levels nor upward currents of air can prevent it falling to the ground as a drop of rain perhaps a tenth of an inch in diameter. The heaviest falls of rain come from





WORLD RAINFALL IN WINTER AND SUMMER

the towering clouds of THUNDER-STORMS, or from TORNADOES (qq.v.) and other forms of whirlwind. In the former, powerful upward currents may carry the lower air up to a height of 4 or 5 miles in a matter of minutes, thus expanding and cooling it to an abnormal extent; in the latter, surface air is similarly raised and expanded with great speed, while to this expansion is added the sucking effect of the whirlwind itself. The conditions which lead to normal rain are described in the articles on WEATHER and CLOUDS (qq.v.).

The wettest parts of the Earth are those reached by winds which have blown for very long distances across the oceans—particularly in warm climates, where the heat increases the rate of evaporation (*see* MONSOON). When such moisture-laden air comes in contact with colder air, as often happens over Great Britain, or is lifted up by convection due to local heating (*see* HEAT, Section 4), by mountains, or by the friction of blowing across land surfaces rather than sea, the result is usually rain, and districts where such conditions often occur have a high average rainfall. Over Great Britain, the average rainfall varies between about 25 and 100 inches per annum, being highest, as might be expected, in the hilly districts nearest the Atlantic, and lowest in the flat eastern counties. As for extremes, there are deserts where rain is almost unknown, and in parts of Burma over 400 inches fall each year. 'Cloud-bursts' can release an immense volume of rain in a very short time. In England a fall of 9·56 inches has been recorded in one day, and on another occasion 2·24 inches fell in forty minutes. When it is realized that one inch of rain on one acre means that 100 tons of water have fallen, the damage caused by such freak downfalls can be understood.

Records of rainfall show that there is little truth in the legend of St. Swithin's Day. Swithin was bishop of Winchester in the 9th century and when he died he was buried in the churchyard —but not, at his own request, in the cathedral. A year later, when he was made a saint, the monks decided to move his body into the more hallowed ground. St. Swithin's Day, 15 July, was chosen for the exhumation; but violent rain, persisting for forty days, caused a long postponement and led to a legend based on the supposed displeasure of the saint—that whenever rain should fall on that date in future, it would continue for forty days. Similar legends are to be found (for different days) in various countries of Europe. It is well that the curses do not work, for if they did, we should be liable to have some very wet summers!

See also FOG; DEW.

RAINBOW. This beautiful spectacle shows us very clearly that what we call 'white light' is really a mixture of many colours—in fact, that it contains 'all the colours of the rainbow'. To see a rainbow we must be between the sun and the rain. The sun's light is reflected back to our eyes by the millions of little curved mirrors which are really raindrops, and at the same time it is split up into its colours by a process known as 'refraction'. If the drops of rain are very large, as in a heavy summer shower, the colours are very bright and distinct on a clear day; if the drops are small, the colours are fainter and more blurred. If they are no bigger than the tiny particles of water we call fog, the colours may get so blurred together that they form white again—and we see the dim white bow that is called a 'fog-bow'. From a balloon or aeroplane we might be able to see a rainbow as a complete circle; but from ground-level we see only as much of it as is not cut off by the earth itself. The most we can see, on level ground, is a semicircle—and to give that the sun must be just setting. In other words, the centre of the bow is always exactly opposite the sun. The higher above the horizon the sun is, the smaller is the arc of rainbow that we see: when the sun is higher than about 40°, no rainbow is possible, because it would all be beneath ground. This explains why we never see one at midday in Great Britain from April to September.

Refraction of light means the bending of its rays when they pass from one transparent substance into another of different density, such as from air into water. Thus refraction causes a straight stick to look crooked if held obliquely half in and half out of water. Now light of different colours is bent by different amounts when it is refracted in this way, red light being bent least, and violet light most (*see* COLOUR). When a ray of sunlight strikes a raindrop, part of it passes through into the water. As it does so, the red in it is bent a little, the violet is bent rather more—and the other colours are bent by amounts between the two. Fig. 1 illustrates this, S being the sun, from which a ray of light is falling on a very large raindrop. When its path

changes from air to water, the red part is refracted a little, and strikes the back of the drop at R; the violet part is refracted more, and strikes it at V. But the back of the raindrop acts as a mirror and reflects both rays out of the drop

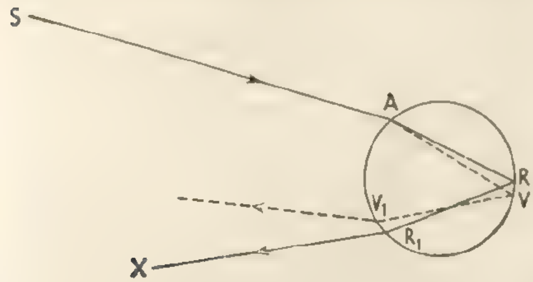


FIG. 1. REFRACTION AND SINGLE REFLECTION OF LIGHT IN A RAINDROP

again at R 1 and V 1. As their paths change from water back to air, the two colours are refracted once more by different amounts, the full line showing the course of the red ray, the dotted line that of the violet. Suppose now that our eye is exactly at X. Obviously we shall only see the red ray, because the violet will pass above our head. But if there were a second raindrop a little lower in the sky than this one, it could be at such a height that we should see its violet ray and not its red. In a shower there are millions of drops of rain at both heights: and from those drops which happen to be at the right angle with our eyes and the sun to reflect red rays we see red light, and from those at a slightly smaller angle we see violet light. So in a rainbow the red arc lies above and outside the violet, the other colours being in between (*see* Colour Plate opp. p. 96).

Sometimes you may have seen a 'double rainbow', in which a second arc in fainter colours

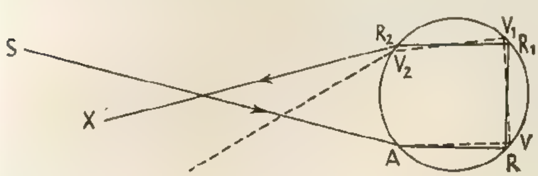


FIG. 2. REFRACTION AND DOUBLE REFLECTION OF LIGHT IN A RAINDROP

lies outside the main one. But have you noticed that in this outer bow the colours are arranged the other way round—the red on the inner and the violet on the outer edge? The reason for this is that the light rays in the second bow have been reflected twice inside the raindrops, instead of only once. Fig. 2 shows how the paths they follow in this case bring the violet rays out at a lower level than the red, and so reverse the order of the colours.

There are two other circles of light occasionally seen in the sky—the 'halo' and the 'corona'. The halo appears as a ring round the sun or moon when the sky is filmed over with cirrostratus cloud (*see* CLOUDS). It is formed in just the same way as a rainbow except that the rays of light are refracted, not by drops of water, but by tiny crystals of ice—for these clouds lie at a great height, where the temperature is always far below freezing-point. The appearance of a halo is a well-known sign of rain—'When the sun is in his house, it will rain soon,' as the old saying has it—and there is much truth in it, because cirrostratus generally forms in front of a depression (*see* WEATHER). The brighter the halo, the more likely the rain (because the greater must be the concentration of ice crystals); and the bigger the halo, the sooner rain is to be expected (because the lower the cloud ceiling, the nearer the depression will be). In a well-defined halo the red of the inner edge can usually be seen, and occasionally a faint yellow beyond it; but the other 'colours of the rainbow' are generally too mixed up to be seen as anything but white.

The rainbow-like corona—not to be confused with the sun's own corona (*see* SUN)—is seen as a circle round the sun, like the halo but smaller, and with its colours less faint and the reverse way round. They are reversed because in a corona the rays of light are not refracted by passing actually through water or ice, but are 'diffracted' or bent by passing between the tiny particles of water making up a particular kind of cloud called altocumulus, which is found at lower levels (and higher temperatures) than cirrostratus. The difference between refraction and diffraction is explained in WAVE-MOTION, Sections 3 and 4. Faint rainbow colourings, also due to diffraction, can often be noticed along the edges of altocumulus clouds. Double and even multiple coronas are occasionally seen. A corona is not so definite a weather-pointer as a halo; but if one is seen to be getting smaller, this may be taken as a sign that the amount of moisture in the cloud is increasing. However, it would be unsafe to prophesy rain from this, unless other signs point the same way.

There is an old saying that if you can reach the foot of the rainbow you will find a pot of gold. This is just a way of saying that you never can reach the rainbow's end. As you move towards it, the colours move away in front of you. Even when you walk right into the rain, the drops falling immediately round you are not at the proper angle with you and the sun to reflect the bow. But you can sometimes get within a few yards—near enough, perhaps, to see the gold if it were really there.

See also CLOUDS; LIGHT; SUN; WAVE MOTION; WEATHER.

RANGOON. The capital and largest port of Burma is situated 20 miles from the sea, on the easternmost delta stream of the Irrawaddy River. It is built on a ridge of firm ground which separates the Irrawaddy and Sitta[illegible]alleys. Since Burma is surrounded on thr[illegible]les by high mountains which can be crosse[illegible] with difficulty, 86% of her trade pas[illegible]rough Rangoon. The principal exports of t[illegible]untry are rice, oil, and teak, the imports b[illegible]otton goods, machinery, coal, and sugar. [illegible] pipe-line over 300 miles long brings cr[illegible] from the wells of Yenangyaung, in centr[illegible]a, to Syriam, a suburb of Rangoon, wher[illegible]ned and prepared for export.

Rangoon has become an importa[illegible] only within the last 100 years. Before [illegible] when Lower Burma became British, there [illegible]nly a small fishing village where Rangoon n[illegible]ands. It was a famous village, however, [illegible]r it was, and indeed still is, the Shwedag[illegible]goda, built in the 6th century A.D., the la[illegible] the

THE GREAT COURT OF THE SHWEDAGON PAGODA, RANGOON. *E.N.A.*

world and one of the principal Buddhist shrines in the East. It rises from a hill, like a huge golden bell, and is visible for many miles, shining in the sun. It is 370 feet high and is covered with thin gold plates. At night the Pagoda is girdled with electric lights, which seem to hang unsupported above the plain.

The modern city near the river is laid out in broad streets of fine buildings, law-courts, and offices of the Government of Burma. Adjoining the modern city are the overcrowded houses of the poorer Burmese and Indian inhabitants, and the bazaars filled with the shops of small traders and jewellers. Farther to the north are beautiful artificial lakes surrounded by trees, and on their banks are the villas and clubs of the rich merchants and officials, and the fine buildings of the University.

The population is diverse, and includes many Chinese and Indians who are employed in the docks and factories. There are about 500,000 people in the city. The colourful dresses of the Burmese and the saffron robes of the many Buddhist priests give an air of holiday gaiety to the streets.

See also BURMA; IRRAWADDY RIVER.
See also Vol. I: BURMESE; BUDDHISM.

RED SEA. This fills a long, narrow depression between Africa and Arabia, about 1,200 miles long and, at its widest point, about 250 miles broad (*see* Map, p. 17). This depression is surrounded by great mountain ranges descending abruptly to a narrow coastal plain, barren and waterless and sparsely populated. Off the coasts are numerous chains of small islands and dangerous coral reefs.

Since no rivers pour fresh water into the Red Sea from the barren lands surrounding it, its waters are very salt, and the degree of saltness is increased by the high rate of evaporation under the intense heat of the sun. In summer the atmosphere is stifling, the temperature of the water sometimes exceeding 80° F. Even at night there is no relief, for the air temperature remains high, and the *khamsin* wind from the land is hot, with no refreshing quality.

Ships enter the Red Sea from the south through the strait of Bab-el-Mandeb, in the middle of which is Perim Island. This island, which is little more than a great rock of volcanic material, is a British naval base, and controls the entrance. At the northern end of the sea,

PORT SAID

the great mass of Mount Sinai towers more than 8,000 feet into the clouds, and on either side of it, narrow arms of the sea extend to the north-east and north-west like the arms of a Y: these are the Gulf of Agaba and the Gulf of Suez. It was somewhere in this area that the Children of Israel, according to the story in the Bible, made their miraculous crossing of the Red Sea into the Promised Land.

At the head of the Gulf of Suez, the SUEZ CANAL (q.v. Vol. IV) connects the waters of the Red Sea with the Mediterranean. It is the canal which has given the Red Sea its importance as a link in the sea route from Europe to India and the Far East. In addition to the fast steamers which pass up and down the Red Sea at full speed, there are a great many smaller ships trading between Red Sea ports. These ships, which may be small, old-fashioned steamers, or even sailing-boats, ply between Port Sudan, Djibouti, and Massawa on the African shore, and Hodeidah and Jedda on the Arabian coast. Jedda is the port at which thousands of pilgrims disembark each year in order to visit Mecca, the holy place of the Moslems. Navigation for these small vessels is difficult in the Red Sea, because of the numerous dangerous reefs near the coast, and the treacherous currents and winds.

Schools of flying fish, porpoises, and sharks follow the ships in the day-time, and at night the water is luminous with points of phosphorescence.

Pearl-oysters are found in the Red Sea, and these are collected by divers off the coastal reefs (*see* PEARL FISHING, Vol. VI).

RELATIVITY. Einstein's theory of relativity, which was published in its complete form in 1915, has upset many of our fundamental ideas about the universe—that is to say, about time, space, matter, and energy. It had always been believed that time and space were quite distinct and different things, as also were matter (the stuff of which everything is made, solid, liquid, or gas) and energy (the capacity to do 'work' or cause action of any kind). The main statements of relativity are (i) that space and time are closely connected and dependent on each other, time being in a way the fourth dimension or measurement of the complete 'space-time continuum', of which the other three dimensions are the usual length, breadth, and thickness; (ii) that no measurements (of space or time) are absolutely true, because they change according to the circumstances of the measurer —i.e. his speed and direction *relative* to what he is measuring; (iii) that matter and energy are fundamentally the same thing, it being possible to convert either into the other. The theory of relativity has now been very considerably proved, and although its laws do not affect our everyday life, since their results do not become noticeable until speeds of thousands of miles a second are reached, they are none the less 'real' and are constantly put to practical use by physicists, astronomers, and other scientists in the course of their work—as, for instance, in the manufacture of the atomic bomb. More important still, perhaps, they have shown us that many of our fixed ideas are wrong, and so have led to quite new ways of thinking.

The reader will find it easier to understand what follows if he has read the article on LIGHT (q.v.), since it was experiments on light which led up to relativity. As a result of the Michelson–Morley experiment, 19th-century scientists discovered that the speed of light remained exactly the same however fast the observer was moving towards it or away from it—which seemed absurd and impossible. In 1893 Fitzgerald suggested that this could be accounted for by assuming that any moving body contracts in length along that measurement which is pointing in the direction of its movement (*see* Fig. 1). The contraction could never be seen or measured, because any measuring apparatus, such as a foot-rule, would itself shrink as soon as it was turned in that direction. At this time, matter was still thought to be made of solid atoms, and the theory was regarded more as an ingenious mathematical trick than as an account of what really happened. We know now that matter is made up of electrically charged particles separated by relatively huge expanses of space (*see* ATOM), and it no longer seems impossible that the mere movement of a body so dependent on electricity should set up magnetic forces of different strengths according to which way and at what speed it moves, and so cause an actual change of shape: it would, in fact, be strange if no such change occurred. The amount of contraction to be expected was calculated mathematically in 1900 and was found to agree exactly with the Fitzgerald Contraction.

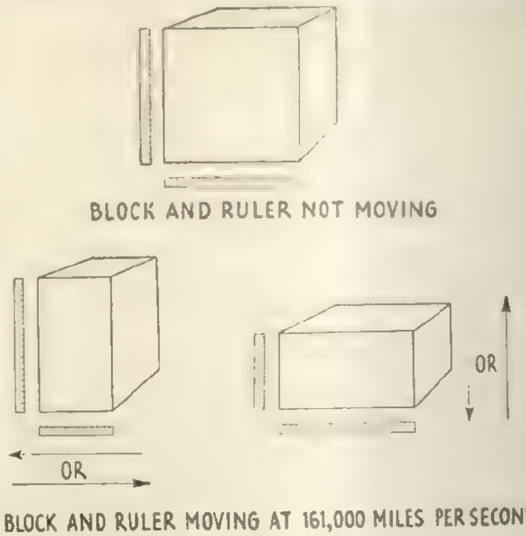


FIG. 1. DIAGRAM ILLUSTRATING FITZGERALD CONTRACTION

EINSTEIN (q.v. Vol. V) published his startling theory of relativity in two parts—the Restricted Theory, dealing only with bodies moving in straight lines at unvarying speeds, in 1905, and the General Theory, dealing with bodies in any state of motion whatever, in 1915. The revolutionary part of the theory lay in a quite new idea of space and time. Until then almost everyone had accepted, without really thinking about it, the view of nature expressed in the following words by Newton: 'Absolute

space, in its own nature, without relation to anything external remains always similar and immovable', and 'Absolute, true and mathematical time, of itself, and from its own nature, flows equally without relation to anything external.' But according to the Fitzgerald Contraction, bodies (which are a part of space) shrink or expand according to their movement relative to the observer; and the 19th-century experiments on light, by proving that its speed remained the same whatever the movement of the observer, had reduced ordinary ideas of time to absurdity (*see* TIME). What Einstein said, in effect, was that space and time cannot be regarded as two separate things: they are, in fact, each just a part of a whole, and very much dependent on each other. The whole he called a 'space-time continuum' (which means a thing whose parts continue or pass into each other), and it contains or will contain all observable happenings, past, present, and future.

Perhaps the easiest way to picture this is to imagine the life of a man as a sort of sausage, so many years (not inches) long. Wherever we cut it, we should see him at some particular moment in his life. But the view of him we should get would not be in the flat (as the cut through a real sausage is), but in the solid, with length, breadth, and thickness. Or we can think of the lives of all mankind as a rope made up of millions of short fibres twisting in and out of each other, each of them the life of one person. If we cut the rope through at 55 B.C., we could get a view of Julius Caesar in the solid, or of anyone else living at that time. The 'past' end of the rope would show the first men of all; the 'future' end would be—who knows how far away? Each of us makes a different cut, and there is no cut of which we can say 'This gives the true view'.

Suppose we marked out an exact square on the Sahara, large enough to be seen through telescopes by dwellers on a distant star; and suppose that star were moving across the sky at 161,000 miles per second, in relation to us. At this speed the Fitzgerald Contraction causes objects to shrink to half their length—and so the star-dwellers would see that we had marked out not a square but a rectangle, its length being twice its breadth. They would be just as right in declaring the shape to be a rectangle as we in holding it to be a square. If we should try to prove them wrong, they would point out that our measuring instruments shrunk when we turned them to measure in one direction; we should say the same of their instruments. Indeed, were they in their turn to mark out a square to be seen from the Earth, we should declare it to be a rectangle, for the effects of the Fitzgerald Contraction and all other happenings due to relativity work both ways. Neither point of view is more right or 'real' than the other—it is merely a question of relativity. This is, of course, a very much exaggerated example: even with the great speeds found in the heavens, the results of the Fitzgerald Contraction are very much less noticeable. For instance, the Earth's speed round the Sun is about 19 miles a second: this means that to an observer in the Sun our globe would seem to contract no more than 2½ inches in its diameter measured along the direction of motion.

As time is, according to Einstein, just a fourth way of measuring the space-time continuum, we should not be surprised to find that its length, too, may change owing to relativity in just the same way that space may shrink owing to the Fitzgerald Contraction. Just as there is no true or 'real' measurement of space, so there is no true measurement of time between two events: to one observer it may seem quite short, to another much longer, while a third may see both events simultaneously—it all depends on their points of view or, as has just been said, on the particular cut each makes through the space-time continuum. Suppose we had noted how long it took us to mark out our square in the Sahara; suppose that the star-dwellers, too, had been timing our progress: if we found that the time taken from beginning to end was twenty-four hours, the distant astronomers would be no less sure that it was forty-eight—and from their point of view they would be no less right (we shall see why in the next paragraph). These, then, are the well-known 'shortening of space' and 'lengthening of time' in the Theory of Relativity.

In addition to proving the constant speed of light through space, the Michelson-Morley experiment led to the conclusion, confirmed repeatedly both experimentally and mathematically, that this speed could not be exceeded by any form of energy or matter. From this Einstein went on to make a further important deduction. The MASS (q.v.) of a body (which,

so long as we are dealing only with bodies on the earth's surface, is practically the same thing as its weight) can be measured by the difficulty of changing its state of motion—that is to say, of making it move faster or slower or, if it is at rest, of making it move. If, then, there is a top limit beyond which speed cannot be increased, argued Einstein, it must be that bodies moving at that speed would possess infinite mass, so that infinite energy would be required to move them. This could only mean that the mass of a body increases as its speed becomes greater. He worked out a formula to give the rate of increase—and it has proved accurate when applied to the mass of particles thrown out by radioactive substances, the only bodies available to us with speeds sufficiently near that of light. (We can now see why the star-dweller's idea of time would differ from our own. Because of the immense speed of their star, the masses of their clocks and of their bodies would be just doubled—and in consequence, not only the clocks, but all the bodily functions of the astronomers themselves would proceed at half the rate of our own.) As might be expected, the increase in mass is in exact proportion to the Fitzgerald Contraction, and, in fact, the formulae for working out these two changes and the expansion of time are all three very similar and—rather surprisingly—very simple.

Einstein did not rest here, however, but went on to declare that mass and energy are really no more than the same thing in different forms. This was a flat contradiction of the two classical laws, the Conservation of Matter and the Conservation of Energy, which laid down that though matter might be turned into different forms of matter, and energy into different forms of energy, none could ever be taken away or added, the total amounts of each in the universe always remaining the same. By the explosion of the atomic bombs the whole world was given a demonstration of the changing of matter into energy—thirty years after the publication of Einstein's theory (*see* Atomic Power, Vol. VIII). The reverse process, the conversion of energy into mass, has also been achieved, though only in the laboratories of atomic scientists.

The theory of relativity is further dealt with in the articles on Space, Time, and Light (qq.v.).

RÉUNION, *see* Indian Ocean Islands.

RHINE. This great river, one of the most important waterways of Europe, flows for nearly 800 miles from the Alps to the North Sea. It rises in Switzerland as a turbulent mountain torrent fed by melted water from glaciers, and flows into Lake Constance. Here the young Rhine loses its burden of mud and gravel, and leaves the lake as a clear dark-green stream. Between Lake Constance and Basle, the Rhine flows westwards, descending the mountains in a series of rapids. It marks the boundary between Switzerland and Germany (*see* Map, p. 160).

From Basle the rift valley of the Rhine stretches northwards for about 180 miles to Mainz. It is bounded on the east by the Black Forest, and on the west by the Vosges, and its floor 20 miles wide is covered with rich alluvium alternating with patches of glacial gravel on which grows thin forest. The Rhine meanders freely along its flood plain, separating into several channels with low islands between. On the fertile soil near the river are grown wheat, hops, tobacco, sugar-beet, and vines. To help navigation, the main channel has been deepened and straightened; but owing to the former uncertain course of the river, few towns have grown up near it.

Below Mainz, the river is diverted sharply westwards for about 12 miles by the Rhine Highlands; but at Bingen it turns north-west and enters the Rhine Gorge, following a straight course through the Highlands for about 80 miles to Bonn. The valley sides rise steeply from the river, and are terraced for vineyards, from which are produced the best German wines. Occasionally, on a spur of rock stands a picturesque medieval castle. The importance of the Rhine Gorge, however, lies in its value as a route, and the river is crammed with barges, while on either bank are railway lines.

The Rhine is well suited for navigation, since its flow is even throughout the year. The snow-melt in the upper reaches of the main stream gives a period of flood in summer, but the main tributaries, the Neckar, Main, and Moselle, have their high-water period in winter, and are low in summer. The result is that the level of the lower Rhine varies very little.

The Rhine carries the traffic of the industrial region based on the Ruhr coal-field. Canals extend the area of navigable waterway, and large towns are frequent. Duisburg is the great river

THE RHINE NEAR COBLENZ, LOOKING UPSTREAM TOWARDS BACHARACH. *E.N.A.*

port, and Cologne (757,000) is the commercial capital of the region.

Near Emmerich, the Rhine changes its direction, and flows westwards to the North Sea, over the flat plain of Holland. It does not meet the sea as a great river, but dissipates its water into several sluggish channels. The three most important are the Ijsel, which flows into the Zuider Zee, the Lek, which has the towns of Arnhem and Rotterdam on its banks, and the Waal, which unites with the Maas near the sea. Canals have been built to assist navigation on the lower reaches.

It is in Germany that the river is most picturesque, and to Germans 'Father Rhine' is a symbol of patriotism. Many legends, like the story of the Lorelei, have grown up about the Rhine.

See also GERMANY.

RHODES, *see* DODECANESE.

RHODESIA. This British colony lies north of the Limpopo River and south of the great African lakes (*see* Map, p. 5). It is 450,000 square miles in area—more than Germany, France, Belgium, and Holland put together.

The Zambesi River divides it into two sections: Southern Rhodesia, which lies roughly between the Limpopo and the Zambesi Rivers, and Northern Rhodesia, lying north of the Zambesi.

The outstanding fact about Rhodesia is that it consists almost entirely of a high tableland or plateau, 4,000 feet or more above sea-level. In this it is like the Union of SOUTH AFRICA (q.v.). As a result, although the whole of the country lies within the tropics, the climate is not really tropical at all. For example, Salisbury and Bulawayo, the two biggest towns, are just as near the Equator as Beira, the town in the Portuguese colony of East Africa which is their port; but whereas Beira has a real tropical climate, with very hot summers and a high rainfall, the two Rhodesian towns have a summer rainfall of about 25 inches and cool winters —in many ways an ideal climate. The importance of this is that Europeans can live comfortably in Southern Rhodesia and fairly comfortably in Northern Rhodesia, while in the neighbouring Mozambique white men find it almost impossible to live permanently because of the extreme heat.

Almost the whole of Rhodesia, except the river valleys, is grass country with plenty of trees. The grass is very high—6 feet on an average, but sometimes 12 feet or more. All

over these grasslands, or 'veld', there are ant-hills, great mounds of earth more than 6 feet high. Some of these ants—white ants or termites—live on wood, so that if every bit of wood used in building is not chemically treated, the ants will completely destroy it. On these huge grass plains there is plenty of game of all kinds, including some twenty kinds of antelope and many lions and leopards. These wild animals have decreased in numbers since Europeans have occupied the land and fenced in the farms with barbed wire; but they are still much more plentiful than in the Union of South Africa.

Cattle-farming is one of the main activities of Rhodesians—for meat rather than for milk, since there is no big market nearby, heavy breeds such as the Shorthorn being favourites. The almost frost-free climate makes the growing of practically every kind of fruit possible, and also allows tobacco to be grown. This last is now one of the most important crops, especially in Northern Rhodesia. Wheat does not grow well because of the heavy summer rains; but maize (mealies) is grown over the whole country and is the main food of the natives.

Rhodesia has no coast-line, and imports and exports go by rail through the Union of South Africa, or to Beira. The great distances make transport very expensive. One railway runs from Bulawayo to Salisbury and then to Beira; the other, from Bulawayo to the Victoria Falls, through Northern Rhodesia to the Belgian Congo border, is part of the Cape to Cairo railway projected by Cecil Rhodes, which now that air travel has become easy, will probably never be completed.

Southern Rhodesia has three world-famous attractions for tourists. The first is the VICTORIA FALLS (q.v.), discovered either by David LIVINGSTONE (q.v. Vol. V) in 1855 or by a Boer trekker a few years earlier. The great Zambesi River, over a mile wide, plunges over a precipice 340 feet high into a deep and narrow gorge only 100 feet in width. The native name for these falls is 'The Smoke that Thunders'. The second famous sight, the Zimbabwe ruins, are the remains of a large fortress, evidently built to protect gold-workings, of which traces also remain. It used to be thought that these buildings showed traces of Arab influence; but it is now fairly certain that they were built by

FRIESLAND CATTLE ON A MASHONALAND FARM, RHODESIA
Public Relations Department, Southern Rhodesia

Bantu people some 400 years ago. The third famous place is the grave of Cecil Rhodes (q.v. Vol. V), the founder of Rhodesia. This is situated among huge granite boulders on the Matopo Hills, not far from Bulawayo. The site was chosen by Rhodes himself and is called World's View.

Southern Rhodesia now has its own parliament, and is on the way towards becoming a dominion, like the Union of South Africa; but Northern Rhodesia, which has a much smaller European population, is governed mainly from England.

Rhodesia is rich in mineral wealth. In the south there are gold and asbestos, and at Wankie there is a large coal-field. This coal is used in the copper belt of Northern Rhodesia which lies just south of the Belgian Congo (q.v.). There are also many other minerals, chromium being the most important. Bulawayo and Salisbury in the south and Livingstone in the north are the chief towns.

See also Africa.
See also Vol. I: Rhodesians.

RHÔNE, *see* France.

RIFT VALLEYS, *see* Rock Formation.

RIO DE JANEIRO. The full name of Rio de Janeiro, the capital of Brazil, is São Sebastião de Rio de Janeiro. But Brazil is a country of shortened names and nicknames, and Brazilians often call their capital just 'Rio'.

The city has a spectacular situation. The main part of it is built on a peninsula between the two wide bays of Rio de Janeiro and Botafago. Behind the city rise abruptly huge peaks of fantastic outline, their granite slopes jagged and bare in places, but for the most part covered with thick forest. The great conical peak of the Sugar Loaf Mountain, the flat-topped Gavea and the weird-shaped Hunchback Mountain seem to be crowding the city out on the shores of the bays. An aerial cableway runs to the top of the Sugar Loaf. On the summit of the Hunchback is a statue of Christ, 135 feet tall. There are magnificent views of the city from these mountains.

To get building space on the peninsula, hills have been flattened and marshes reclaimed. The broad Avenida Rio Branco runs for over a mile across the peninsula. Near its southern end are theatres, the Law-Courts, and the National Library of Brazil. At its northern end are the docks. The oldest part of the city is between the Avenida Rio Branco and the tip of the peninsula. Here, in a confused pattern of streets, are the banks, offices, and warehouses. The principal church, the Candelaria Church, was built in 1775 and has a finely decorated interior. Broad, tree-lined promenades, brilliantly lit at night, lead to the suburbs along the shores of the bays. The many beaches, the houses gay with roof-gardens, loggias, balconies, and verandas, and everywhere the brilliant colours of bougainvillea, plumbago, and blue convolvulus, make the suburbs of Rio very attractive.

RIO DE JANEIRO, SHOWING THE SUGAR LOAF MOUNTAIN
New York Times

Rio is an important airport and seaport. Coffee, sugar, hides, and diamonds are valuable exports. Flour milling, brewing, and sugar refining are among the main industries. As the riches of Brazil are more and more developed, so will Rio de Janeiro grow in importance. At one time it was an unhealthy city, ravaged periodically by yellow fever. To-day, as a result of improved sanitation and an excellent water-supply, it is one of the healthiest cities in the tropics. Rain falls between November and May; and during the sultry summer season round Christmas, the President of Brazil, many

members of the government, and others move to Petropolis in the hills near by. Rio de Janeiro is the second largest city of South America.

See also BRAZIL.

RIO DE LA PLATA, *see* ARGENTINA.

RIVERS differ greatly in character. There are swift-flowing rivers, slow, sluggish rivers, mighty rivers with several mouths, rivers that carry vast loads of alluvium to the sea and discolour its water many miles from their mouths, clear, limpid rivers, rivers that at some seasons of the year have very much more water than at others, rivers that are made to generate vast quantities of electricity by their power, and rivers that carry great volumes of traffic and are often the main highways of the regions through which they pass (*see* RIVER NAVIGATION, Vol. IV).

Most rivers begin in springs (*see* WELLS AND SPRINGS) or by the joining-up of numerous rivulets and streams of water. Some, however, emerge as full-grown rivers from CAVES in limestone country or from the lower end of GLACIERS or from LAKES (qq.v.). Practically every river has an upper, a middle, and a lower part—though one of these may be very much longer than the others. The upper river is the part where the main work of the water is cutting—cutting down towards sea-level or the level of the lake into which it is flowing, and cutting forward along its course. In the middle part the main work is the carrying away of the material cut. In the third part, the lower river, the main work is the depositing of the material. To a certain extent, of course, these three types of work—cutting, carrying, and depositing—are carried on in all three parts: it is their relative importance that differs.

THE UMLAAS RIVER, NATAL, CUTTING DOWN TOWARDS SEA-LEVEL THROUGH HORIZONTAL LAYERS OF ROCK

In its upper part a river usually occupies the whole of the foot of its valley—for the valley is likely to be narrow, steep-sided, and ravine-like (*see* VALLEYS). It flows swiftly and turbulently, and its bed is generally rocky and boulder-strewn, probably broken by rapids and waterfalls.

Lower down, in its middle reaches, the river flows more slowly, but is still flowing swiftly enough to cut away its bank. So it usually runs between well-defined margins, and there is little danger of flooding.

The lower stretches of rivers show considerable variety. Many wind across their valley floor in broad loops. These are continually being changed by the cutting action of the water, so that near the river there are usually remnants of earlier courses in the form of crescent-shaped lakes ('ox-bow lakes') or marshy hollows. Such rivers often cause floods, since their banks are low and the 'flood plain' bordering them is flat. Other rivers flow so slowly that the alluvium they carry is deposited on the river-bed and, in time of flood, along its sides in embankments (or levées). Eventually this may result in the river being raised above the level of the surrounding country. The MISSISSIPPI (q.v.) in part of its lower course does this. Still other rivers deposit their load as a delta—a fan-shaped deposit—through which channels wind their way to the sea or lake into which the river flows. The NILE, the AMAZON, the YANGTSE-KIANG, the SI-KIANG, the YELLOW RIVER, or Hwang Ho, the DANUBE, the RHINE, the GANGES, the IRRAWADDY, the MISSISSIPPI (qq.v.), and countless smaller rivers enter the sea by deltas.

Some rivers have such a heavy load of fine alluvium in their waters that all is not deposited in the delta—and then the sea is discoloured by the muddy fresh-water currents which for some distance do not mix with the salt sea-water.

TIDENHAM BEND, A LOOP OR MEANDER ON THE RIVER WYE
Crown Copyright Reserved

This happens off the China coast, where the Yellow River carries out vast quantities of yellow silt. The Amazon, too, stains many miles of the Atlantic dark red.

All rivers change in volume with the season of the year—some very considerably. The 'regimen' (as the pattern of this seasonal variation is called) of a river belongs to one of the four main types—or to a combination of these types if the river has important tributaries of regimen different from its own. In tropical areas, since the temperature is practically the same all the year round, loss of moisture by evaporation is almost constant, and variation results mainly from the uneven distribution of rainfall: with the rains the rivers rise. In regions like north-western Europe, where rainfall is distributed throughout the year and where temperature varies considerably from one season to another, a regimen is found in which rivers are fullest in winter, since rainfall is greatest then, and there is less evaporation. The third regimen is that of rivers which are fed from snow-fields, such as the rivers in north U.S.S.R., Canada, the Alps, and other high mountain ranges. These become swollen with the melting of the snow and ice; but in winter they have practically no flow. Widespread flooding often accompanies the spring thaw, as the rivers cannot carry off the sudden increase in water. The fourth regimen is found where both temperature and rainfall are very seasonal. In countries with Mediterranean climate, hot weather and lack of rainfall coincide—so that rivers which have been torrents in winter often have dry beds in summer. In some areas of continental climate, such as central Russia, the main rain falls in the summer—so that the rivers are fullest at that season.

Lakes have an important effect on river regimen. If a river in flood (or in 'spate') enters a lake, its increased volume spreads over the whole area. This may make little difference to the level of the lake; but the river will leave having lost its flood characteristics of increased volume and speed.

Rivers have many important functions. They have been used from earliest times as boundaries, and as route-ways, and in dry countries to irrigate the land. More recently they have provided power for the generation of electricity.

Perhaps the most famous river boundaries have been the Rhine, the Danube, and the Mexican–U.S.A. boundary following the Rio Grande and the Colorado River. A river makes

a good boundary, since, unlike a land boundary, it is easily seen and crossings are not difficult to control. It has been said, too, that as a river is a valuable possession—especially a navigable river—it is only fair that it should be shared by the countries concerned rather than that the boundary should follow one bank. In the cases of the European rivers, international commissions were set up to form and follow a policy of development. There has been no trouble in deciding the position of the boundaries. In America, however, both the Rio Grande and the Colorado River have changed their courses since the boundary was fixed, and there has been confusion and trouble as a result.

In earlier times, before the development of efficient land transport, rivers were often the only route-ways. Frequently the country through which they flowed was marshy or forested, or very hilly, and the only easy means of movement was by water. This is still true in Africa in the lands round the CONGO RIVER (q.v.), in America in the Amazon Basin, in Russia in the far north areas, and in the Amur Basin (*see* R.S.F.S.R.). In other regions, river transport is important because it is cheaper than road or rail transport, especially for heavy raw goods such as grain, iron, or coal. In Europe, the Rhine and the Danube are important for their barge traffic, while Russia has a vast system of inland waterways linking up the White Sea, the Baltic, the Caspian, and the Black Sea with the Rivers North Dvina, Volga, and Dnieper. In America, the Mississippi carries much merchandise, as do the rivers of the Great Lakes system of waterways, the ST. LAWRENCE (q.v.), and the Hudson.

Electricity is generated by water-power in practically every part of the world where the need exists and the water is available (*see* POWER-STATIONS, ELECTRIC, Vol. VIII). One of the largest schemes is that which harnesses part of the water of the NIAGARA FALLS (q.v.).

Rivers are being increasingly made use of by man. Locks are constructed to enable shipping to overcome obstacles such as shallows, rapids, and waterfalls; dams and reservoirs, such as the Lloyd Barrage on the River INDUS (q.v.) in India, are built to obtain regulated flow for power or irrigation schemes, as well as to reduce the risk of flooding. But in regulating a river for one purpose it may well be that an earlier benefit is lost. For instance, the building of dams across the NILE (q.v.), for irrigation in the Anglo-Egyptian Sudan, is causing silt to be deposited, with the result that the Nile water which floods the fields of Egypt farther down the river has lost much of its fertilizing qualities, and expensive artificial manures have to be used in increasing amounts.

ROARING FORTIES, *see* WIND

ROCK-CRYSTAL, a form of quartz, is the only colourless stone found in large supply. In Roman times it was used by the rich for goblets, glasses, and bowls, and some of the earliest seals were made of it. To-day it has many uses. Good specimens are cut and polished for jewellery, since although it lacks the 'fire' of diamond it is very beautiful. As it is very hard, it does not scratch as readily as glass, and it is therefore much used in optical and scientific instruments. A peculiar property of rock-crystal is of importance in connexion with the polarization of LIGHT (q.v.).

Rock-crystal occurs in igneous rocks. Brazil is the chief source of supply; but Madagascar, Japan, Hungary, Switzerland, and the U.S.A. also produce it, and small quantities are found in Wales, near Derby, and in southern England.

'Cairngorm' is a brown or yellow form of rock-crystal which is found in the Scottish mountains of that name (and also in other parts of the world), occurring both in granite rock and in alluvial (or river-formed) soil. The cairngorm figures prominently in Highland costume —in dirk handles and plaid brooches, for instance.

See also MINERALS and ROCKS.

ROCK FORMATION. The ROCKS (q.v.) of the Earth's crust are continually influenced by many forces: gravity acts on all of them; those below the surface layer are also under pressure from above, and the rhythmic up-and-down movements of the Earth's crust, described in MOUNTAIN BUILDING, may cause upward pressure from below.

The simplest result of these forces is the folding of sedimentary rocks. As these were formed in the basins of shallow seas, they lie in strata (Lat. *stratum*, a layer) which were originally completely or almost completely horizontal; but in

being uplifted to form land, the strata have usually become buckled.

A simple fold forms an arch (called an 'anticline', because the beds slope away from the crest) and a trough (called a 'syncline', because

FIG. 1. UNIFORM DENUDATION

the beds slope together towards the bottom of the fold). Where such simply folded sedimentary rocks have been exposed to DENUDATION (q.v.), the surface may develop as shown in Fig. 1; for as the upfolded rocks are more easily denuded (or worn away) than the downfolded, a number of the beds of rock become exposed on the Earth's surface. The area of exposure is called the 'outcrop' of the rocks.

Fig. 1 shows what would happen if all beds were of equal hardness and wore down to the

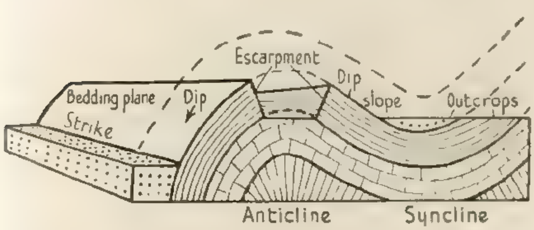


FIG. 2. DIAGRAM TO ILLUSTRATE GEOLOGICAL TERMS

same extent; but usually the harder rocks are left, forming an 'escarpment' (Fig. 2). The direction of the maximum slope down a bed of rock (i.e. down its 'bedding plane') is the direction of 'dip'; and the angle of dip is the angle between this slope and the horizontal. The 'strike' of an inclined bed is a horizontal line along its bedding plane, where it cuts level ground or the surface of still water.

Folds are often very complicated and are not always symmetrical (Fig. 3). They may be inclined, even to the extent that the order of the strata on the surface is reversed. When this happens, the fold is called an 'inverted' fold or 'overfold'. Under great pressure, as happens during mountain building, tongues of rock may be bent right over to become 'recumbent' folds (Lat. *recumbere*, to lie down). In overfolding, the middle limb of the fold often tends to get squeezed out. In many cases this is followed by the thrusting of the whole of the upper limb along what is called a 'thrust-plane'. The upper limb is called a 'nappe' (Fr. table-cloth), because it hides the rest of the original structure. Nappes are found extensively in mountain ranges, especially in the Alps, where there is a series of thrust-planes.

A 'fault' is the splitting of a series of beds of rock so that the beds on one side of the split are moved upwards, downwards, or sideways in relation to the beds on the other side. A fault is said to be 'normal' if the plane of splitting slopes in the direction in which beds appear to have dropped. It is said to be 'reversed' if the plane slopes in the direction in which beds appear to have risen. Reversed faults usually indicate pressure upwards and sideways. Faults occur not only on a small scale, in which rocks drop merely a few inches, but also on a gigantic scale in which rocks over vast areas appear to have moved up or down thousands of feet. This phenomenon is usually called 'block faulting' or 'plateau faulting', since great blocks of the Earth's crust are involved. In such cases it is difficult to decide whether the higher blocks have risen or the lower blocks have sunk, or

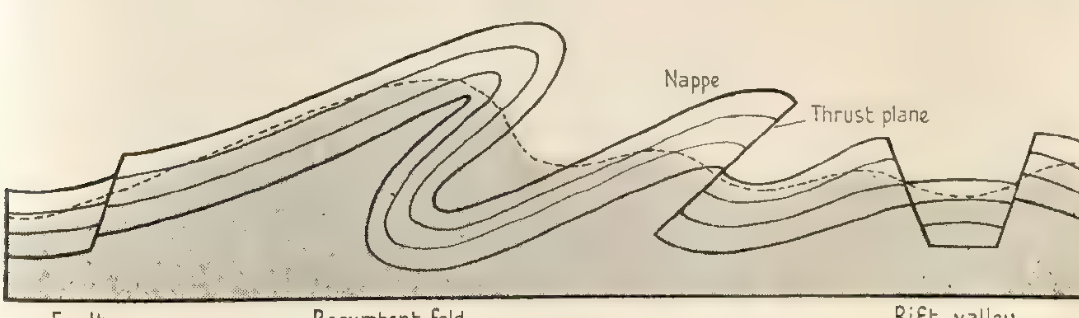


FIG. 3. FAULTS AND FOLDS: THE SHADED PART GIVES THE FORM OF THE DENUDED LAND

whether both have moved, but in opposite directions. The third explanation is the most probable.

When a block of land sinks between two unmoving blocks, a 'rift valley' is formed. An example of a rift valley is the valley of the Rhine (q.v.), where sedimentary rocks have sunk between the harder rocks of the Vosges Mountains on the west and the still harder granites of the Black Forest on the east. Rift valleys are occupied also by the Dead Sea (q.v.) and by the great lakes of East Africa. There is little doubt that the crack in the Earth's crust which stretches from the Jordan (q.v.) through the Red Sea and Abyssinia, and forks into the valleys of the East African lakes, is of profound significance: it extends for more than one-sixth of the Earth's circumference, and the severe earthquakes which occur from time to time along it show that movement along this fracture is still going on. Much geological investigation and mapping is necessary, however, before any explanation can be offered.

When a series of beds of sedimentary rocks is found to have been laid down on other rocks in such a way that its bedding bears no relation to the bedding of the rocks underneath, an 'unconformity' occurs, that is to say the upper beds do not conform or fit in with the lower beds. Unconformity is almost always the result of the raising of the lower beds of rock either to a level where waves eroded them, or, more generally, to above sea-level where, as sediments, they were eroded. If the surface of the lower beds of an unconformity shows an eroded surface, it is in a sense a fossilized land surface. Fig. 4 illustrates the forming of an unconformity in a case where the lower beds had been worn into a perfectly flat land surface.

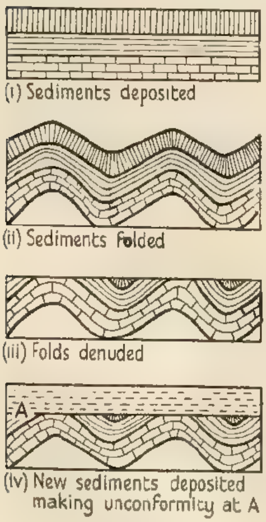


Fig. 4.
HOW AN UNCONFORMITY IS MADE

All types of rock develop cracks known in geology as 'joints'. Hard sedimentary rocks, such as limestones and sandstones, generally develop these at approximately right angles to their stratification or bedding. There are frequently two series of joints, one series more or less in the direction of dip and the other in the direction of strike. Joints simplify greatly the task of the quarryman, because they form roughly rectangular masses. They also hasten denudation by rain, ice, plant roots, and the sea.

In igneous rocks, jointing results from cracking during cooling. In 'granite' masses there are usually three series of joints, two of which are nearly vertical to the surface and at right angles to each other, while the third series is parallel to the surface. Quite a different system of cracks develops in 'basalt', which, because it cooled on the Earth's surface, cooled much more rapidly than granite. The cracks in basalt are rather like the many-sided cracks which occur in dried-up mud (*see* Giant's Causeway).

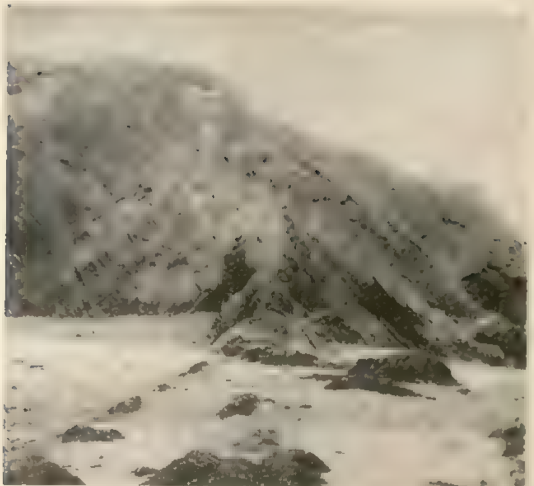
In addition to lavas poured out by volcanoes, rock of basaltic type known as 'dolerite' rose to the Earth's surface either through cracks more or less at right angles to the strata or by forcing a passage along and between bedding planes.

Fig. 5. IGNEOUS INTRUSIONS

Such formations are known as 'igneous intrusions' (Fig. 5). In the first case the dolerite forms 'dykes', and in the second case it forms 'sills' (Anglo-Saxon *syl*, a ledge). Dyke is a very suitable name. It can mean a wall or a ditch—and dolerite dykes are sometimes lower than the rocks they cross and sometimes higher, depending on whether they are softer or harder, and therefore wear away more rapidly or less. Dykes vary in thickness from a few inches to hundreds of feet; but most are between 5 and 20 feet thick. The most famous example of a sill is the Great Whin Sill of the north of England, along the top of which runs part of the Roman Wall.

'Laccoliths' (Gk. *laccos*, a cistern; *lithos*, a rock) occur where the intrusive rock, failing to burst through the overlying strata, arches them up as is shown in Fig. 5.

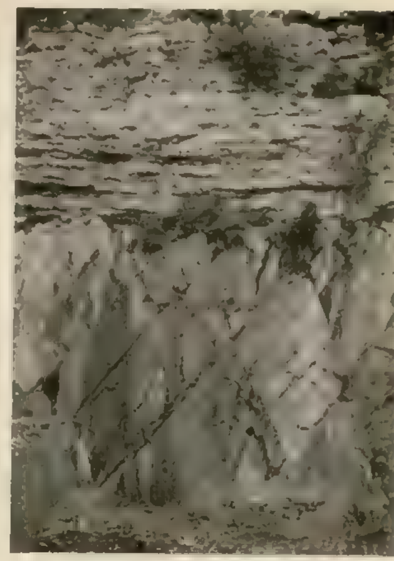
'Batholiths' (Gk. *bathos*, depth) are gigantic



AN ANTICLINE AT BUDE, N. CORNWALL

A SYNCLINE AT BUDE, N. CORNWALL

JOINTING IN ROCK
Lane End quarries, Yorkshire



UNCONFORMITY: CARBONIFEROUS LIMESTONE ON ROCKS OF THE SILURIAN PERIOD, YORKSHIRE

masses of granite which must once have been at great depths below mountains and volcanoes —now worn right away. It is possible that some batholiths represent the underground basins from which a line of former volcanoes was fed. Smaller rounded knobs of granite exposed by denudations are known as 'bosses'.

See also Earth; Earth, History of; Mountain Building; Rocks; Denudation.

ROCKS. **1.** In geology, 'rock' means any considerable body of Minerals (q.v.) or material derived from minerals. It can therefore mean a mass of granite, a layer of gravel, soft clay, or even a bed of loose sand.

Rocks are classified by the way they were made. Those formed from molten material are called 'igneous' (Lat. *ignis*, a flame); those formed from particles which have settled on the Earth's surface, or in lakes, or in shallow sea are called 'sedimentary' (Lat. *sedere*, to settle), whilst rocks which were originally either igneous or sedimentary, but which by pressure or heat or both have been changed, are called

'metamorphic' (Gk. *meta*, change; *morphe*, form).

2. Igneous Rocks. (*a*) Some molten rocks actually cooled on the Earth's surface. They are called 'igneous, volcanic'. Because they cooled quickly, the minerals of which they are composed did not form large crystals. 'Basalt' (*see* Giant's Causeway) is a good example of this kind of rock. Its crystals are very small, and contain so much iron that it is very heavy and almost as black as soot. There are tiny crystals of lighter material—'feldspar'—in it; but they can be seen only under a microscope. Basalt is the rock which in a molten or semi-molten condition is believed to constitute the plastic 'subcrust' of the Earth (q.v.).

Often the outer surface of a very liquid lava-flow cools so quickly that no crystals form, and the rock looks like dark glass. Such rock is called 'obsidian' (after Obsius who first described it), unless it is black, when it is called 'pitchstone'. If the lava is full of bubbles of steam and other gases which escape when it reaches the surface, the rock called 'pumice' is formed. This is so full of holes that it is very light. When volcanic ash, often containing fragments of pumice, consolidates to form rock, the rock is known as 'tuff' (*see* Volcanoes).

(*b*) Other molten rocks did not cool on the Earth's surface, but cooled beneath layers of other rocks. Then the cooling took place much more slowly, so that the minerals were able to form crystals which are easily visible to the unaided eye. This type of rock is called 'igneous, plutonic' (after Pluto, the god of the Underworld). The best-known plutonic rock is 'granite', which contains the three minerals quartz, feldspar, and mica. Where there is no quartz present, but there is feldspar and mica and minerals rich in iron, then the rock is probably 'gabbro'. The classification of igneous rocks is complicated, and except for certain very common types, the naming of an igneous rock is a task for the expert. A rock which is sometimes mistaken for granite, but which is intermediate in composition between granite and gabbro, is 'syenite'. A typical syenite contains feldspar, mica, and iron-bearing minerals such as augite, or olivine, but little or no quartz.

(*c*) Intermediate in crystal structure between plutonic and volcanic rocks are rocks which have been injected into the Earth's crust and have therefore cooled faster than plutonic rocks but slower than volcanic ones. In general their mineral crystals are intermediate in size between those of basalt and gabbro. A rock typical of this type is 'dolerite'.

Sometimes the molten rock underwent considerable slow cooling before it was injected into a crack to form a dyke. During the slow cooling some large crystals formed. The remainder of the rock then cooled quickly, forming small crystals. A rock which has large crystals set in a mass of much smaller crystals is said to have 'porphyritic' structure, or to be a 'porphyry'. The name was given originally to a purplish rock of this character found in the Near East (Gk. *porphyra*, purple).

3. Sedimentary Rocks. All rocks, when acted upon by the weather (*see* Denudation), gradually break up, and the mineral particles are either blown away by the wind or carried by streams into lakes or into the sea. Sooner or later the particles settle in layers and so form sedimentary rocks.

(*a*) *Wind-formed.* The rock formed by layers of wind-blown particles is called 'loess', after a town of that name in Alsace where rock of this type is found. During the retreat of each of the ice-sheets of the Ice Age (q.v.), rock dust was spread out in fan-shaped deposits by the melting ice. Wind blew much of this dust southwards to warmer regions where grass was growing ('steppe-lands'), and here it was held entangled. Each spring the grass grew on the dust collected during the previous year, and the withered grass roots below helped to keep the layers of rock dust firm. A long belt of loess stretches across the plains of north Europe and the U.S.S.R. (where it forms the fertile 'black earth').

In China it occurs on a vast scale. The dust which made the loess of China came, however, not from glacial streams, but from the sands of the hot deserts of Asia. From every desert of the world the wind carries away vast quantities of the finest rock dust. It may fall on the surface of the sea, or on lakes, or it may be trapped by vegetation, especially in grasslands. The loess of China is hundreds of feet thick, and as it is very soft it has been cut by rivers into deep valleys with steep sides. In parts of the western states of the U.S.A. and in the Mississippi valley there is a rock of similar origin, called 'adobe'.

(*b*) *River-formed.* The sedimentary deposit formed in valleys and plains by the mud and

rock substance washed down by rivers and streams is given the general name of 'alluvium' (Lat. *ad*, to; *luere*, to wash). It often includes GRAVELS and SANDS (qq.v.).

(*c*) *Lake-formed.* Sedimentary rocks formed in inland seas or lakes become apparent only when the lake dries up. The commonest rocks laid down in lakes are GRAVELS, SANDSTONES, and CLAYS (qq.v.). These often contain important mineral deposits. When a lake begins to dry up, the first substance deposited is usually a thin layer of iron hydroxide; carbonates of calcium and magnesium follow, then 'gypsum' (calcium sulphate), and later rock-salt (sodium chloride). SALT (q.v.) continues to be deposited almost in a pure state until 95% of the water has evaporated, and then the other salts which are present crystallize. These include chlorides of potassium and magnesium, and very small quantities of bromides, iodates, and borates.

(*d*) *Ice-formed.* The sedimentary material left by retreating GLACIERS (q.v.) includes gravels, sands, and a deposit called 'boulder-clay' or 'till'. Boulder-clay contains stones of all sizes up to large boulders, which have been collected on the moraines of glaciers. They are set in rock-dust for which the name clay is quite unsuitable, since the finer particles are really a flour made by the grinding together of fragments of many different rocks under pressure from the ice. On geological maps boulder-clay and glacial sands and gravels are often grouped together as 'drift' (*see* GLACIATION).

(*e*) *Sea-formed.* Most of the rock material worn away from the Earth's surface comes to rest in the shallow seas round the coasts. Here we find material blown from deserts, or torn down by the waves battering on the shore, or carried down to the sea by rivers (*see* DENUDATION). When a river enters the sea, its speed and carrying power are reduced, and it drops its load—first gravel, then sand, then mud—and only the finest suspended particles get carried out to sea.

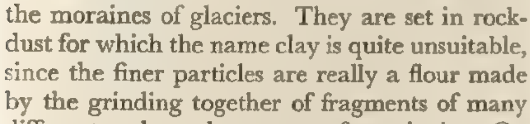


FIG. 1. THE SEDIMENTS IN A SHALLOW SEA

A section cut from shore to shore across a shallow sea would show the sediments accumulating somewhat as in Fig. 1. In all sediments there are remains of animals and plants that live in the sea; but farthest away from the shore, where the sea is clearest, the sediment consists mainly of fragments of animals that like clear water, such as shell-fish, sea-lilies, sponges, or the shells of minute animals. It is then an organic sediment. Under certain circumstances this may eventually be transformed into petroleum (*see* OIL, NATURAL).

Where the water is clear enough and warm enough, there may be a coral reef along the shore or near it. Fragments of coral (*see* CORAL ISLANDS) are continually washed away and accumulate in the sea nearby, forming LIMESTONE (q.v.). If the coast-line is a swampy tropical forest which gets buried by layers of silt, seams of COAL (q.v.) eventually result. When these sea or marine deposits eventually appear above the surface of the water they are classed as sedimentary rocks (*see* MOUNTAIN BUILDING).

Shingle cemented with sand-grains forms 'pudding-stone', or CONGLOMERATE (q.v.); sand becomes SANDSTONE (q.v.); from mud comes CLAY (q.v.) or, if it is in biscuit-like layers which split apart readily, 'shale'. From organic sediments come limestones if the fragments are 'calcareous', i.e. consisting mainly of calcium carbonate as in the case of coral, or sea-lilies, or shell-fish; should the organic sediment in shallow water have consisted of minute animals called 'globigerina' (*see* OOZES)—a comparatively rare happening—the hardened sediment is chalk.

Beds of any type of sedimentary rock slowly merge into beds of other types, and so intermediate layers occur, such as sandy clays and clayey limestones.

4. METAMORPHIC ROCKS. Some sediments which accumulated to a very great depth have been pressed down into hotter regions of the Earth, and folded (*see* MOUNTAIN BUILDING). They have become changed into metamorphic or transformed rocks. Sedimentary and igneous rocks may be transformed also by the welling up of lava or gases from the sub-crust (*see* ROCK FORMATION). In either case new rocks are formed—and sometimes it is difficult to know from what type they were derived.

If a fairly pure sandstone is metamorphosed, no new mineral can be formed, because sand is mainly quartz in tiny grains: all that happens is that the grains of quartz melt and then recrystallize. But whereas in a sandstone there are

crevices between the rounded grains, when it melts these crevices become filled and the resulting rock is very hard and compact. It is then known as 'quartzite'. Similarly, when a fairly pure limestone, which consists of grains of calcium carbonate, is metamorphosed, the grains of calcium carbonate cool into a compact mass of crystals. A common type of crystalline limestone is the beautiful white Carrara marble. 'Marble' is not a special kind of rock, but is the name given to any rock which will take a polished surface, though usually it is a crystalline limestone.

'Slate' is a metamorphic rock which has the peculiar property of splitting into thin layers. This is due to the orderly arrangement in parallel planes of minute flaky minerals such as mica and chlorite. It is formed under enormous pressure from a clay, a shale, or even, in the case of the silver-green slates of the Lake District, from a volcanic ash.

When great heat and great pressure are applied to a rock, it may form a new structure resembling tightly packed leaves. This is called 'foliation' (Lat. *folia*, a leaf). When foliation occurs throughout, the rock is called 'schist' (Gk. *shistos*, divided). Every schist is named after the mineral chiefly responsible for its foliated structure, and so there are mica-schists, chloride-schists, and so on.

Perhaps the best known of all metamorphic rocks is that known by the old German miners' term 'gneiss'. In this rock several different minerals appear in almost parallel bands. The commonest forms of gneiss contain the same minerals as granite, namely quartz, feldspar, and mica, and the rock looks very much like a granite in which the minerals have been rearranged in bands. As would be expected, gneisses and schists are found commonly in the folds of great mountains, and they are the principal rocks of the Alps.

See also MINERALS; ROCK FORMATION; EARTH, HISTORY OF; MOUNTAIN BUILDING.

ROCKY MOUNTAINS. This great system of parallel mountain ranges stretches for 4,000 miles down the western side of North America from Alaska to New Mexico. In Canada the ranges are fairly close together and the plateaux between them are relatively narrow. In the United States there are wider plateaux and high plains, such as the Laramie Plains in Wyoming and the Bitter Root valley in Montana. Many peaks rise to over 14,000 feet above sea-level, and the highest, Mount Logan in Canada, is over 19,000 feet. Some of the peaks have gentle slopes or rounded tops but very many of them are precipitous and rugged, and well suit their name 'rocky'. To the traveller passing through them they appear to be enormous, fantastic, and endless.

For long, the Rockies cut off the Pacific seaboard of Canada and the United States from the rest of North America. In the early 19th century they were visited only by trappers, hunting bear, puma, deer, and other fur-bearing animals. Later, the discovery of gold, copper, coal, silver, lead, and iron, of the oil-fields in Wyoming, and of one of the largest phosphate areas in the world in Idaho led to the building of roads and railways. To-day there are three great railways across the Rockies: the Union Pacific Railway in the United States, the Canadian Pacific, and the Canadian National. The Canadian Pacific climbs highest and runs through the Kicking Horse Pass at a height of over 5,000 feet above sea-level. A remarkable Canadian road was completed in 1940. It runs from Banff to Jasper in Canada, 160 miles as the crow flies, and is one of the greatest mountain roads in the world. Like all routes over the Rockies, it crosses vast tracts of primeval forests and great swamps, follows rocky canyons, and spans swiftly flowing glacier-fed rivers, affording magnificent views of high peaks, limestone gorges, deep ravines, and blue lakes of still water reflecting snow-capped mountains and forested slopes.

Within the Rocky Mountains there are many national parks where trees, plants, animals, and birds are protected. The largest of these is the Yellowstone National Park in Wyoming, with its great GEYSERS (q.v.), its herds of bison, deer, and antelope. Then there are the Rocky Mountain National Park in Colorado, and the Glacier National Park in Montana. The latter has about sixty small glaciers and hundreds of alpine lakes in its rugged mountains. Canada has two very beautiful parks, the Banff National Park and the Jasper National Park, in which are some of the finest mountain, lake, and forest land in the Dominion.

Among all the wonders and curiosities of the Rockies, two perhaps deserve mention. One is the grizzly bear, now a rather rare inhabitant, whose fierceness and shyness, great size and

THE ROCKY MOUNTAINS FROM THE NATIONAL PARK, BANFF
High Commissioner for Canada

extreme deftness in moving have made him almost a legendary animal. The other is the great redwood tree, with its amazingly tall, straight trunk, branchless for hundreds of feet from the ground, and its growth so mighty that carriage roads have been cut through its trunk.

Several great rivers rise in the Rocky Mountains, including the Colorado, the Columbia, the Rio Grande, and several of the great tributaries of the MISSISSIPPI (q.v.). The melting snows of the great summit areas and the rainfall on the windward eastern slopes of the mountains supply these abundantly with water.

See also NORTH AMERICA.

ROME (CITY OF THE SEVEN HILLS). Rome was the centre of ROMAN CIVILIZATION (q.v. Vol. I). It was the centre of Christianity in western Europe (*see* CHRISTIAN CHURCH, Vol. I), and is still the centre of the ROMAN CATHOLIC CHURCH. It was one of the centres of the Italian RENAISSANCE (qq.v. Vol. I) and is to-day the capital of modern ITALY. No city in the world, therefore, has played a larger part in the history of our civilization.

The earliest Iron Age settlements occupied a group of hills, separated by marshy valleys. According to the legend, Romulus built his city in 753 B.C. on Palatine hill, one of the seven hills near the mouth of the Tiber. Although centuries of levelling have considerably altered the original contours, Rome still retains her title of 'City of the Seven Hills'. From this nucleus the ancient city developed. Bridges were thrown across the Tiber, the marshes were drained, and shops and houses occupied the low-lying spaces. The extended area was surrounded by a great wall, the Wall of Servius. When Rome ceased to fear an invader, the wall was no longer needed, and houses and gardens spread over it in parts. It was not till the reign of the emperor Aurelian (A.D. 270–5) that the city was refortified because of the danger of attack from barbarian hordes.

Rome, before the great emperors, was a city of narrow, winding streets; one-storeyed houses of sun-dried brick lined these, except where an occasional blind wall, composed of square blocks of volcanic stone, marked the residence of a noble. The Capitol, Rome's citadel and religious centre on the Capitoline hill, long remained a sacred area reserved for temples, and in particular for that of Jupiter Capitolinus, most celebrated of all. The centre of civic life was the Forum, which lay in the hollow between the Capitoline and Palatine hills. In this restricted area the central paved space was devoted to public gatherings and displays. Round it stood shops and offices, together with monuments and shrines of various periods. On slightly higher ground were the senate house and the Rostrum, the platform for orators, which faced the Forum.

AN AERIAL VIEW OF ROME

In the foreground is St. Peter's with the Vatican on the left. In the background, beside the River T[illegible]s the Castle of St. Angelo, dating from the 2nd century. *E.N.A.*

Here took place some of the most dramatic events in Republican history.

But, in spite of its increasing size and importance under the Republic, the capital had remained, by contemporary Greek standards, a mean city. Under the earlier Emperors, however, Rome was transfigured, and by the 2nd century A.D. it had attained its greatest splendour. JULIUS CAESAR's bold plans for remodelling the Forum were completed by AUGUSTUS (qq.v. Vol. V)—although its unique position was diminished by the magnificent public buildings, including the Imperial Fora, which successive rulers erected. Augustus reorganized the administration of the city; police and fire brigades were instituted, the Tiber banked, and additional aqueducts built to improve the water-supply. Temples were rebuilt in stone, and permanent theatres replaced the earlier wooden structures. Basilicas, or pillared halls, huge bathing establishments, colonnades and triumphal arches sprang up on all sides, and statues filled every available space. Palaces and great houses crowned the hills, while the poorer inhabitants crowded into blocks of flats. At its greatest extent the population of the city, drawn from all parts of the Empire, must have numbered nearly a million. Imperial Rome had become the metropolis of the civilized world.

With the rise of Constantinople in the 4th century, Rome's star waned. The centre of gravity was shifting to the East, and emperors, busy on the frontiers, rarely visited the old capital. Nevertheless its capture by the GOTHS (q.v. Vol. I) under Alaric in 410 was felt as a universal disaster. After its sack by the VANDALS (q.v. Vol. I) in 455, the ruined buildings were left unrepaired, and the population grew steadily smaller. During the Gothic siege of 537, the aqueducts were damaged, and the surrounding country laid waste. Imperial Rome was no longer important; but Rome had long assumed

a new significance as a pre-eminent centre of CHRISTIANITY (q.v. Vol. I). In the 4th century, after freedom of worship had been granted by CONSTANTINE (q.v. Vol. V), buildings for Christian worship began to appear—among them the Lateran, Santa Maria Maggiore, and old St. Peter's, where CHARLEMAGNE (q.v. Vol. V) was crowned Holy Roman Emperor in 800. Many other churches, as well as monasteries, arose in the centuries which followed, built largely from materials, including precious coloured marbles, taken from classical monuments. Throughout the Middle Ages, Rome was a place of pilgrimage, and from pilgrim's guidebooks its appearance at this time can to some extent be reconstructed. Sites of martyrdom were specially visited. But the buildings of Imperial Rome, to which strange legends were attached, still dominated the scene.

During the 6th and 7th centuries, Rome had depended on Byzantine protection against external attack. When the BYZANTINE EMPIRE (q.v. Vol. I) became more separated from the west, the Frankish rulers for a time took over this role. Then there followed a period of constant warfare and disruption, when Rome became a battleground of rival nobles, and her great ruins were turned into fortresses. By the end of the 15th century the Papacy had proved the victor, and Rome became the centre of the Papal States. This victory coincided with a renaissance of all the art in Italy, and was followed by a period of intense building activity, which saw the reconstruction of the Vatican Palace, now the fixed residence of the Popes, and the erection of the new ST. PETER'S CATHEDRAL (q.v. Vol. XII). The 17th century, age of baroque architecture, gave to present-day Rome much of its characteristic appearance. Medieval churches were remodelled in the taste of the time and magnificent palaces and fountains enhanced the beauty of streets and squares. In 1870, when the Papal city became the capital of the Kingdom of Italy, modern Rome began to take shape. The Tiber was embanked and spanned by new bridges, suburbs sprang up to house the growing population (to-day well over a million), administrative buildings multiplied, and the opening up of communications swept away many old quarters. Recent developments include the clearing and displaying of important sites of the Republican and Imperial periods.

ROTTERDAM, *see* HOLLAND.

ROUMANIA. This country lies at the extreme east of Europe with its eastern boundary on the Black Sea (*see* Map, p. 160). Six countries—Russia, Poland, Czechoslovakia, Hungary, Yugoslavia, and Bulgaria—share frontiers with it. The huge waterway of the DANUBE (q.v.), which forms most of its southern boundary, is joined by the Prutu, the Siret, and other tributaries, and flows by a number of mouths into the Black Sea. The CARPATHIAN MOUNTAINS (q.v.), curving from the north-west, meet the Transylvanian Alps in the middle of the country.

The Roumanian climate is one of great extremes. The winters are often as cold as in any part of Russia. Snow lies for nearly half the year in the high mountain passes. Bitter winds sweep the plains; and the Danube waterway may be ice-bound for as long as three months. In contrast, the temperature may rise to 100° F. in summer.

Eastern Roumania is an enormous plain, providing pasture for great herds of cattle and growing crops of wheat, maize, oats and other

A CARAVAN IN THE WESTERN CARPATHIANS, ROUMANIA
Roumanian Legation

grains, peas, beans, potatoes, vines, and tobacco. Western Roumania is very mountainous. Many thousands of acres are covered with forest. Trees are cut in the mountains, floated down the lesser rivers to the Danube, and thence to the Black Sea. There are salt, coal, iron, and gold mines—and mineral springs, some of which have been famous since Roman times. Oil is the greatest single industry, the centre of the oil-fields being Ploesti, north of Bucharest.

The first Kingdom of Roumania was made up of the provinces of Moldavia and Wallachia. It was recognized as independent in 1878. As a result of the Balkan Wars of 1912–13 and of the First World War, the territory of Roumania was almost doubled in extent. Dobrugea, between the Lower Danube and the Black Sea, was acquired from the Bulgarians, Transylvania from the Hungarians, North Bukovina from the Austrians, and Bessarabia from the Russians. Much of this territory was, however, lost again after the Second World War.

The capital is Bucharest (q.v.). Galati, the principal Roumanian port for the export of timber, was the headquarters of the International Commission that regulated traffic on the Danube. Braila is the headquarters of the grain trade. Graiova, which takes its name from the Roman Castra Nova, is an important centre of trade in southern Wallachia.

See also Vol. I: Roumanians.

RUBY. Rubies, like Sapphires (q.v.), are corundum, an oxide of aluminium, and are very hard. Large rubies are rare. If they are of fine quality they are much more valuable than a diamond of equal weight and quality. Pigeon-blood red is the rarest and most expensive colour. Colour varies, Siamese rubies tending to be darker than Burmese, while those from Ceylon are pale.

Rubies are crystals and are usually six-sided prisms. 'Star rubies', which can be cut to produce a star effect within the stone, are found very occasionally. In these there are internal cavities parallel to the sides; so that if the stone is cut suitably, light is reflected from the inside.

The best rubies come from the region round Mogok in Upper Burma. Mining is usually done by open trenches in the weathered limestones of the area, though sometimes tunnels are dug into the hill-sides. At Mogok a bazaar is held about three times a fortnight. Bidding is done silently and secretly, hand and finger pressings indicating the offers made.

Synthetic rubies are made fairly easily and are of very little value.

See also Minerals; Colour Plate op.

RUSSIA, *see* R.S.F.S.R.; U.S.S.R.

R.S.F.S.R. **1.** The Russian Soviet Federative Socialist Republic occupies about three-quarters of the U.S.S.R. It stretches east from the Gulf of Finland to the Bering Sea and the Sea of Okhotsk, and south from north of the Arctic Circle to the Caspian Sea and the mountains of central Asia (*see* Map, p. 459).

Administratively it is divided into fourteen Autonomous Soviet Socialist Republics, six Autonomous Provinces, and nine National Regions. These each send representatives to the Soviet (or Council) of the R.S.F.S.R. in the ratio of eleven deputies from an Autonomous Republic, five from an Autonomous Province, and one from a National Region. The R.S.F.S.R. itself is represented in the Soviet of the whole U.S.S.R. like the other Soviet Socialist Republics.

The Great Plain of Russia stretches from the western borders of the R.S.F.S.R. to the River Yenisei, and extends as an Arctic coastal belt east of the Yenisei to the River Lena. The Ural Mountains (q.v.) cross it from north to south, and there are hilly or undulating areas in the Kola Peninsula in the extreme north-west, to the west and south of Moscow, and south of Gorki. Otherwise it consists of vast areas of very flat, low-lying land.

2. The Tundra and Taiga. In the far north of the Great Plain, in the semi-desert frozen 'tundra' lands of the Arctic coast, the people, originally hunters and trappers, now depend increasingly on their herds of semi-domesticated reindeer. In the tundra lands, winter lasts for about nine months, and even in the short summer only the surface of the soil thaws out. This annual partial melting of the ice results in marshes and temporary lakes. The tundra grows little but stunted vegetation, mostly mosses and lichens and dwarf trees. With the coming of the thaw many bright-coloured flowers spring up for a short spell of life. South of the tundra lies the 'taiga', or coniferous forest land, with its immense wealth of largely unexploited forests with their valuable fur-bearing animals. The

taiga lands take up altogether about one-third of the area of the whole U.S.S.R. In Europe the trees are mostly pines and firs, but farther east a considerable number of larches and cedars are also found. In the west, lumbering is the main occupation. There are many saw-mills and pulp, paper, and cellulose industries, as well as the important match industries of LENINGRAD (q.v.). Round Leningrad there are dairy farms and market gardens, and flax is grown. Elsewhere potatoes, oats, and grass are cultivated. Along the coast and in the White Sea, fishing is very important. As well as being a timber-exporting port, the Arctic city of Murmansk is the centre of a big trawl-fishing fleet. In the Kola Peninsula, the Khibin Mountains have mineral wealth producing aluminium, fertilizers, copper, iron, mica, and nickel.

In the central belt, from the White Sea eastwards to the Ural Mountains, the tundra and taiga regions are very flat and have been developed with the aid of water transport by the rivers North Dvina and Pechora. A system of canals links the North Dvina to the Volga and the Neva. Timber is floated down to the saw-mills and to Archangel for export; coal is shipped from the Pechora Basin and grain is brought by river from the Volga lands. In this region all the buildings and most of the roads and pavements in the towns are of timber, since it is easily available. There is considerable mineral wealth in coal, oil, iron, and salt.

East of the Urals, the Great Plain of Russia continues across north-western Siberia to the Yenisei River. The climate is so severe that the rivers are likely to be frozen for as much as seven months of the year. The people are mainly nomadic and are fur-traders, hunters, fishermen, and reindeer-breeders.

3. THE CENTRAL REGION. In European U.S.S.R., the taiga is bordered to the south by undulating country, marshy when low-lying and of poor gravelly soil at higher levels. Much of the western part of this area is marshland which has been drained to form meadowland and treated with fertilizers to grow good crops of rye, oats, flax, and hemp. Forestry is important. Linen-mills, saw-mills, and paper-mills have been built in many towns. Round Moscow, potatoes are an important crop and there are many market gardens, piggeries, and dairy farms. Farther south, the more fertile soils used to be covered by deciduous forest; but to-day all that is left are small clumps of trees breaking up the big fields of sugar-beet in the south-west and wheat, oats, rye, and millet in the south-east.

Brown coal and peat are used to generate electricity for the industry which was attracted to the area by its central position and by its densely packed population—offering at once an abundance of labour and great consuming centres. Moscow (q.v.) and the neighbouring towns have big engineering industries of all types and very important textile industries—cotton, silk, linen, wool—with the chemical industries that are complementary to them. Synthetic rubber and boot and shoe manufactures are also important. Railways, roads, rivers, and canals combine to provide an excellent transport network linking the Moscow area with all parts of the U.S.S.R.

4. THE VOLGA LANDS. East of the Central Region, the Volga lands stretch southward from the taiga to the Caspian Sea with the Ural Mountains as their eastern boundary.

A REINDEER IN THE TUNDRA
S.C.R.

From ancient times the River Volga (q.v.) has been an important routeway, and its boatmen have become world-known in song. Their heavy wooden barges carry, in particular, wheat, salt, timber, and coal. The northern Volga lands are forested; and the old industries of the region are based on timber—cellulose, paper, matches, and furniture. Recently, however, Gorki (Nijni-Novgorod) has become a great motor- and vehicle-building centre with works based on imported iron and peat-generated electricity.

Farther south, the Volga lands become increasingly grain lands, except near towns, where market gardening and dairy farming are the main agricultural occupations. In the extreme south, irrigation has been employed to extend the cultivated area, though near the river and its delta the spring floods ensure rich soil for orchards and melon gardens. Lush meadows provide pasture for cattle, and cotton, tomatoes, and vines are cultivated. The lower river teems with fish, the best known being the sturgeon whose roe is caviare.

Stalingrad is the centre of the lower Volga region. It is a city on the junction of routes from north to south and east to west, a river port, and a rail centre with easy communication to the rich lands of the southern U.S.S.R. and the coal-fields of the Ukraine.

5. Siberia and the Far East. East of the Ural Mountains and south of the taiga, the plain of western Siberia stretches to the Yenisei River. The climate is so cold and dry that deciduous trees cannot grow, and so the taiga extends to the 'steppe' lands of the south. Dairy farming is carried on south of the taiga, while apple orchards have been developed round Omsk. Farther south, grain is the main crop—grown on vast mechanized farms. The steppe lands stretch from the Ukraine (q.v.) to the Yenisei. They have cold, bitter winters and hot, dry summers, with enough rain to grow grass and grain but not enough for trees. The rich steppe land of the Ukraine in the west consists of great open plains covered with fertile black soil. The Siberian steppes are less fertile—in places almost desert.

The extreme south-east of western Siberia rises gradually to the foothills of the Altai Mountains of Mongolia (q.v.). This foothill region is made up of flat plains enclosed by steeply rising hills. Farther south and east, in Khakass Autonomous Province, high, steep-sided ridges with snow-capped peaks enclose broad valley basins. The valley sides are usually wooded with thick forests, mainly of cedar and larch. Sheep are fed on the high pastures, and on the valley floors cattle are kept and oats and barley cultivated. Lumbering is important. Much of the Altai Mountains is very beautiful—its rugged forested country, with fine lakes, deep gorges, torrents, waterfalls, and snow-capped peaks, suggest great tourist possibilities.

Industry has grown up round the coal deposits of the Kuznetsk basin and the iron ore of the Ural Mountains. Gold, copper, manganese, and zinc are mined. Zinc is imported, too, from Kazakhskaya (q.v.). Wolfram and molybdenum are also imported, and a big steel industry has developed.

East of the Yenisei River, the plateaux of north-eastern Siberia stretch to the Tungu Mountains and continue eastward through the Yakutsk A.S.S.R. to the River Lena. The Siberian plateaux contain valuable deposits of graphite, iron, nickel, and gold. Coal is mined in the Tungu Mountains. In the north, the people are reindeer-breeders and hunters, and there is a great trade in sable pelts. The south of eastern Siberia is part of the region of high mountain ranges, plateaux, and deep valleys, which sweeps east and north from the upper river Yenisei, south of the upper river Lena, to the great mountain lake Baikal, the third largest fresh-water lake in the world.

To the north, the valley of the River Lena is very important. Yakutsk, the largest town and the centre for the Yakutsk A.S.S.R., is on the river. This is navigable for four to five months of the year up as far as 2,500 miles from its mouth and for about 1,000 miles above Yakutsk. Many of its tributaries are also navigable. Rivers are the main thoroughfares of the region, the few roads following their valleys. The Arctic coastal plain which the Lena crosses (as do several similar rivers to the east) is flat and bare. In winter it is frozen, in summer it is covered by marshes, mud banks, and lakes,

The Yakuts rear yaks and ponies, hunt, and cultivate barley and rye on their small terraced fields. But new methods of agriculture are now being adopted, and industry is growing up round the Lena coal basin and the iron deposits. The timber from the vast forests is being increasingly exploited.

Along the coast of the Sea of Okhotsk there is

THE VOLGA LANDS. *Pictorial Press*

a narrow plain with a very unpleasant climate—cold, wet summers and frozen seas in winter. The people fish, hunt seals and fur-bearing animals, and breed reindeer. There are rich gold-mines. Off the coast is the peninsula of Kamchatka with its high parallel mountain ranges and central lowland. This volcanic peninsula has hot springs and active volcanoes with snow-capped peaks rising to a height of about 16,000 feet above sea-level. The mountain sides carry rich forests, the home of bears and other fur animals. Wild sheep graze on the pastures, and the rivers teem with salmon. Fish-canning is important.

South of the crest of the mountains which form the south-eastern border of the Lena basin, there is a mountain region draining southwards to the River Amur and to the Pacific coast, off which lies the island of Sakhalin. The important River Amur, a boundary of Manchukuo (Manchuria), is navigable for some 2,000 miles, and its head-streams, the Shilka and the Argun, and many of its tributaries have also long stretches of navigable waters. The valley of one of these, the Ussuri, gives an easy route south to VLADIVOSTOK (q.v.). Large tracts of this region are sparsely populated; but in the neighbourhood of the rich gold, coal, lead, and iron mines, vast new industrial areas have grown up, densely peopled by immigrants, Russians and Ukrainians, from the west. One of these industrial centres is the Amur valley at Blagoveshchensk, another is at the junction of the Amur and the Ussuri, at Khabarovsk, while a third is at Vladivostok. Northern Sakhalin has very rich petroleum resources and coal-mines.

It is apparent that this vast republic of the Union of Soviet Socialist Republics contains resources of incalculable extent and richness, and has certainly a greater potential ability to be self-supporting than any other region in the world. The exploitation of its wealth has only begun within the last twenty years; but the rapidity with which this has gone ahead, in spite of—or in some cases because of—the Second World War, indicates very definitely the importance of the R.S.F.S.R. in any world economy.

See also U.S.S.R.
See also Vol. I: RUSSIANS; SIBERIAN PEOPLES.

S

SAHARA DESERT. 'Sahara' is an Arabic word meaning 'desert'. This desert in North Africa is part of an enormous belt of desert land which stretches eastwards across Arabia into central Asia. The Sahara covers an area of about three million square miles—about twenty times the size of the British Isles, and stretches from the Atlantic Ocean to the River Nile, across the widest part of Africa (*see* Map, p. 5). Here and there are oases, usually far apart from each other, where fresh underground water bubbles through the sand, making it possible for animals and plants to live.

Early travellers called the Sahara a 'sea of sand'. This is a good description of areas such as the Libyan Desert, where there are stretches of dazzling white sand, in some places blown into great wave-like dunes, in others firm and hard. But the greater part of the Sahara consists of vast areas of bare reddish sandstone rock, rising towards the centre of the desert into high plateaux, such as the Ahaggar in Algeria and Tibesti in the Sudan. From these barren rock-strewn plateaux, called *Hamadas*, rise high ranges with peaks up to 8,000 feet in height, covered with snow for several months of the year.

THE SAHARA DESERT

Lehnert and Landrock, Tunis

The desert temperature, except in the high places, is generally above 90° during the day. Hot dry winds spring up suddenly, bringing 'desert devils' or sand-storms; and very occasionally, at intervals of years, rain may fall, usually in a short, violent storm. The nights are cold and clear, and the stars seem very large and bright in the dry atmosphere.

The Saharan oases are connected to each other by well-marked routes used by desert travellers. In the larger oases there are permanent settlements of tribes who grow on the fertile soil such crops as figs, peaches, oranges, grain, and dates. But apart from the oasis-dwellers, the normal inhabitants of the Sahara are nomadic Moslem tribes such as the Bedouin and Tuaregs (q.v. Vol. I), who wander from place to place in search of scanty pasture for their camels. They are dependent on their camels not only for transport, but for coarse camel-hair cloth and for milk. Some of the tribes breed horses, cattle, and sheep in the more fertile valleys of the plateau region.

All routes across the Sahara converge in the south-west of the desert at Timbuktu which, with a population of about 5,000, is the only town of any size. It is in French Sudan (q.v.). Tracks which have been trodden for centuries by camel caravans are now used by motor-buses; for to-day it is possible to travel quickly and fairly comfortably across the desert by bus from the Mediterranean coast to the Niger River.

Most of the territory of the Sahara belongs to France. There is a prosperous trade carried on in dates, salt, soda, and saltpetre. The desert population as a whole is estimated at about two millions.

See also Deserts; Algeria; Egypt; Libya; Sudan.

ST. HELENA. This island, about $10\frac{1}{2}$ miles long and $6\frac{1}{2}$ miles broad, lies in the South

THE ST. LAWRENCE JUST ABOVE QUEBEC
Royal Geographical Society

Atlantic more than 1,000 miles off the coast of South Africa (*see* Map, p. 322). It was a useful port of call for ships going round South Africa to the East Indies. In the 17th century it was seized by the East India Company and is now a British possession. After the Battle of Waterloo, the island was used as a suitable place of exile for NAPOLEON (q.v. Vol. V).

St. Helena is an extinct volcano, with cliffs up to 2,000 feet high descending sheer into the sea on three sides. From the wall of the crater, water-cut gorges stretch in all directions, widening as they near the sea into deep valleys. Although the island lies within the tropics, the south-east trade winds keep the climate cool. The 5,000 islanders, who are of mixed European, East Indian, and African descent, almost all live on a high plain in the north-east end of the island. Now that ships no longer travel to the east via South Africa, St. Helena's prosperity as a port has diminished, and there is hardly enough to support the population. Recently, however, flax-fibre and lace-making industries have been established.

ST. LAWRENCE. Jacques CARTIER (q.v. Vol. V), the bearded sailor from St. Malo who was the first European to discover the St. Lawrence River, called it 'the ready way to Canada'—and a very good description it is, for it was a ready way for Indian braves in their war canoes, for French explorers and missionaries, for General WOLFE (q.v. Vol. V) on his way to capture QUEBEC (q.v.) and so to lay the foundation of British dominion, and to-day it is still a ready way for trade, commerce, and tourists. Cartier never realized the true greatness of his discovery. He was disappointed to find that the river did not lead him to the stately temples and glittering wealth of the Orient. However, he was impressed by the beauty and fertility of the neighbouring country, and he always spoke of the St. Lawrence as the River of Canada. The name 'St. Lawrence' he gave only to the small bay in the Gulf which he happened to enter on St. Lawrence's Day, 1536.

In Cartier's time the St. Lawrence flowed through thick forests. To-day most of them have been cleared. In some places it flows through cultivated land which extends right to the edge of the water; in other places, as at Quebec, it is in a cleft bounded by steeply rising rocky banks. In some stretches it is bordered by small villages with high-spired churches, at others by apple

orchards and maple woods or pine forests, and at others it passes extensive modern factories. It is crossed by many fine bridges. One of them, the Victoria Jubilee Bridge at Montreal, is a mile and a quarter long and so wide that it has separate tracks for trains, trolley-buses, road vehicles, and pedestrians.

The importance of the St. Lawrence to Canada is very great. It flows from Lake Ontario and so has direct communication with the GREAT LAKES (q.v.), from which it provides the shortest freight route to Europe. It is connected with the Hudson valley of the U.S.A. and New York by a wonderful system of canals, the finest of which is the WELLAND SHIP CANAL (q.v. Vol. IV). For the greater part of its course it is a very broad river, capable of taking ocean-going liners to MONTREAL (q.v.) a thousand miles from its mouth, and reaching a width of about 90 miles near the Gulf of St. Lawrence. It links Quebec, Montreal, Toronto (on Lake Ontario), and Ottawa, the great cities of eastern Canada. OTTAWA (q.v.), the capital, is on the River Ottawa, the largest tributary of the St. Lawrence.

The construction of canals has overcome such obstacles as cataracts and rapids, but the St. Lawrence has a still greater drawback—every winter it freezes as far downstream as Quebec, about 150 miles from its mouth. This means that Montreal is usable as a port for only seven months of the year. However, the importance of the river has been emphasized by a recent agreement (1941) between the Governments of Canada and the U.S.A. (the St. Lawrence is the boundary between the State of New York and the Province of Ontario) which provides for the spending of £70,000,000 to improve it as a waterway to the Atlantic Ocean.

See also CANADA; RIVERS.

SALT. This substance is well known to everyone and because of its characteristic taste is more easily recognized than any other mineral. Chemists know it as sodium chloride and call it 'common salt' to distinguish it from a whole range of chemical compounds which they class as salts. It is lucky for mankind that salt is 'common', because it is perhaps the most valuable mineral in the world; we could do without gold and platinum and diamonds, but without salt most of our food would be unbearably tasteless and our health would be very

SALT PANS, MALTA
R. Gardner

seriously affected. Fortunately, [illegible] is widely distributed over the world in [illegible] of many geological ages (though there [illegible]eas where none is found), and it has been [illegible]nated that the seas and oceans contain e[illegible] dissolved salt to form a continent about fi[illegible] times the size of Europe.

Natural salt occurs either as c[illegible]tals or, dissolved in water, as 'brine'. Beds o[illegible] 'rock-salt', perhaps hundreds of feet thick, are found either on the surface—there are mountains of salt in Spain, the Punjab, and elsewhere—or underground. Rock-salt forms in cube-shaped crystals and, when absolutely pure, is colourless and transparent; but in its natural state it is usually coloured brown, red, purple, or blue by the presence of other substances. Brine often overlies rock-salt, as in Cheshire and other parts of England, and there are surface SPRINGS (q.v.) of brine in many parts of the world. There are also great lakes of brine, of which the best known are the DEAD SEA and the GREAT SALT LAKE of Utah (qq.v.). In desert regions, large areas of salt crystals often remain as evidence of dried-up salt lakes; or salt may have been drawn to the surface during the very infrequent rains and then left there by evaporation. As petroleum is derived from organic matter originally deposited on the sea bottom (*see* OIL, NATURAL), it is not surprising that engineers frequently find salt when they are boring for oil and, in fact, look upon its presence as a hopeful sign. In volcanic

districts, salt is sometimes deposited by condensation straight from its gaseous form—which suggests that the masses of steam given out by VOLCANOES (q.v.) may be due to water which has escaped through cracks under the sea-bed. Geologists believe that all natural salt and brine deposits have been derived originally from sea-water. In the simplest process an arm of the sea is sealed off by a rising sand-bank, and as the water dries, the salt is left behind. Or in the vast geological movements described in MOUNTAIN BUILDING (q.v.), when whole continents slowly sank beneath the sea and new lands rose up in their stead, there were opportunities for great seas to be lifted to positions where the supply of water from streams and rivers would not equal their loss by evaporation, and again the result would be beds of salt.

But most rock-salt is thought to have come from sea-water by a less direct process. Many of the rocks of the earth's crust were originally formed in the sea, or have at some period or other been submerged beneath the sea. Many of them, therefore, contain a proportion of salt. As rain-water runs over them or oozes through them, it dissolves and carries some of this with it. In the case of lakes with no outlet, the amount of water supplied by streams and rivers must be roughly equal to the amount lost by evaporation. As salt does not evaporate at ordinary temperatures, this means that the saltness of such lakes continually increases until, as in the present case of the Dead Sea, salt begins to crystallize out at the bottom in the form of rock-salt. The fact that beds of rock-salt with a thickness of 4,000 feet are known gives some idea of the millions of years through which this action must have continued.

See also EARTH, HISTORY OF; MOUNTAIN BUILDING; ROCKS, Section 3 (*c*) and (*e*).

SALVADOR, *see* CENTRAL AMERICA.

SAMARKAND, *see* UZBEKISKAYA.

SAMOA, *see* PACIFIC ISLANDS; *see also* Vol. I: POLYNESIANS.

SANDS AND SANDSTONE. A rock is said to be a 'sand' if it consists of small loose particles of mineral the average size of which does not exceed a twelfth of an inch—about the size of a radish seed. Sands which have accumulated under wind action, either in deserts or along the shores of a sea or lake, consist usually of very rounded particles; sands which have been formed by GLACIERS (q.v.) consist of very angular particles, while those deposited by rivers or along the sea-shore or on the beds of shallow seas and lakes are intermediate in roundness.

Sand particles can be of many minerals, but the most common are, naturally, grains of those minerals which are hardest and least easily decomposed. Of these by far the most important is 'quartz', which forms almost 100% of the sands used for the making of glass.

Sands which have been subjected to great pressure consolidate to form 'sandstone'. Sandstones such as the Old Red Sandstone of England and Wales and the New Red Sandstone of the Midlands and northern England have been much used for building. Their red colour indicates that the sands were desert sands. Sandstones formed in the sea often contain minute flakes of the mineral mica, which give the rock a sparkling appearance. The flat mica crystals settle in parallel layers, and sometimes micaceous sandstones can be split into thin sheets. Another form of sandstone formed in the sea is the so-called 'greensand', which owes its colour to a greenish mineral called 'glauconite'. Some sandstones, such as the Wealden Sandstone of Sussex, are grey or yellowish-brown.

See also ROCKS, DENUDATION; MINERALS.

SAND-STORM, *see* DESERTS.

SAN FRANCISCO. No city in the U.S.A. has more glamour than San Francisco. It is situated on a peninsula which is bounded on the north and east by San Francisco Bay, on the south by wooded hills and fertile valleys, and on the west by the Pacific, which is entered through a channel called the Golden Gate. It has a magnificent, land-locked harbour which may have been sighted by the great Sir Francis Drake. Spaniards were the first settlers, then Mexicans, and in 1847 it became part of the U.S.A., by whom its bay had long been coveted as a provisioning and refitting station for whalers, and a fine centre for trade. With the discovery of gold in California two years later, San Francisco experienced mushroom growth. From a quiet village of less than a thousand people it became in little more than a year a busy, lawless, cosmopolitan town of 60,000. The

SAN FRANCISCO BAY LOOKING TOWARDS THE BERKELEY HILLS
Paul Popper

end of the gold boom was followed in the late 1850's by a period of depression, later succeeded by a smaller silver boom, the cause of another financial crisis. The city was saved by the completion of a transcontinental railroad in 1869 and helped by the completion in 1913 of the Panama Canal, which brought added trade and prosperity to its port. This event was celebrated in 1915 by a Great Exhibition, and another was held in 1939–40 to commemorate the bridging of the Golden Gate and the Bay by magnificent suspension bridges many miles in length (*see* GOLDEN GATE BRIDGE, Vol. IV).

San Francisco has suffered much from earthquakes and fires—the worst being the great SAN FRANCISCO EARTHQUAKE (q.v.) of 1906; but it has emerged triumphant from them all, retaining its romantic, cosmopolitan character. The new city is much finer than the old, but it still has its picturesque Chinatown and its populous Italian district, and it still gives an impression of gaiety, lavishness, and adventure. It has over 600,000 inhabitants. Of its many industries, fruit, meat packing, oil refining, and sugar refining are among the most important. And it will be known in history as the meeting-place of the Conference which, in 1945, after the close of the Second World War, drew up the Charter of the United Nations.

See also UNITED STATES OF AMERICA.

SAN FRANCISCO EARTHQUAKE. SAN FRANCISCO (q.v.), on the Californian Coast of the U.S.A., has experienced many disastrous fires and earthquakes, the most terrible and most destructive being those of April 1906. In the early morning of the 18th, the first and heaviest shocks were felt, less severe tremors were experienced during the day and in the two days following. Damage was serious. Buildings crumpled, streets became masses of rubble, and many gas and water-mains were fractured. But probably worse and more terrifying than the shocks, were the great fires caused by the burning gas escaping from the broken mains. These fires raged for four days and resulted in indescribable panic. Clouds of dust from fallen buildings, illuminated by the flames, made day a ghastly twilight. The flames were so fierce that buildings had to be destroyed by dynamite and artillery to prevent the fire spreading. About one-third of San Francisco was destroyed, and the loss of property was estimated at one hundred million pounds. Some 500 people lost their lives—a low figure considering the magnitude of the disaster. But more than a quarter of a million were made homeless, and they flocked into devastated streets, the Golden Gate Park, and neighbouring cities. The tragedy caused world-wide sympathy. Through the medium of the Red Cross, money and supplies poured in from Europe and Asia as well as from America. The work of reconstruction was carried through very quickly, and within three years a new city had arisen on the ashes of the old one. It was better planned and had finer and more substantial buildings, so that a more beautiful San Francisco emerged from the debris and the ruins of the old.

See also EARTHQUAKES.

SAN MARINO, *see* ITALY.

SANTIAGO. This city of nearly a million inhabitants, the largest in South America west of the Andes, is the capital of Chile. It is situated in the foothills of the Andes Mountains, almost 2,000 feet above sea-level, and has a magnificent climate. Behind it, to the east, the main Andes range rises to a height of over 13,000 feet. To

the west is a wide, fertile plain, through which the Mapocho River runs to the Pacific port of Valparaiso. Santiago can be reached from the east by the Trans-Andine railway. This runs from Buenos Aires, piercing the mountain range at a height of nearly 11,000 feet by a long tunnel.

Santiago is very hilly. On one of these hills, called 'the rock of Santa Lucia', stands a statue in honour of Pedro de Valdivia, a companion of CORTEZ (q.v. Vol. V) who founded the city in 1541. Santiago has had an unlucky history. It suffered from rebellion among the early Spanish settlers, from attacks by Indians, from earthquakes, and from floods. To-day, the Mapocho River crosses the city in a channel 130 feet wide, with high stone walls to prevent flooding. The streets are laid out in a rectangular pattern. One of the loveliest is the long Avenida de las Delicias, which runs through the heart of Santiago for about 2 miles, bordered by fine houses and trees. The Cathedral, which stands in the main square, marks the site of the city's oldest church. This was founded by Valdivia, but was destroyed in an earthquake and rebuilt to a new plan. There are several other fine churches and a beautiful palace for the archbishop.

As Santiago is the centre of the Chilean government, it has the residence of the President, big government offices and law-courts, as well as theatres, libraries, museums, an art gallery, and a university.

See also CHILE.

SAPPHIRE. Though the most costly sapphires are cornflower blue, other colours are also valuable for use in jewellery. Thus there are white sapphires, yellow sapphires (or 'oriental topazes'), green sapphires (or 'oriental emeralds'), and purple sapphires (or 'oriental amethysts'). All are corundum, an oxide of aluminium, as are rubies. Like ordinary corundum, which is impure and granular and is used as an abrasive, they are very hard. Sapphires are slightly harder than rubies. They are found as much larger stones and are considerably less valuable.

Sapphires are crystals, nearly always twelve-sided prisms. All are transparent and translucent. 'Star sapphires' are quite common, much more common than 'star rubies'. These stones can be cut to produce a star effect within the stone because they contain cavities parallel to the sides of the prism.

The largest and finest stones come from Kashmir in north-west India. Sapphires are found also in Burma, Siam, Ceylon, Queensland in Australia, and in Rhodesia.

Many sapphires are historically interesting. One, which is heart-shaped and is now in the British Crown Jewels, once belonged to Darnley, husband of Mary Queen of Scots. Another, mounted in a ring, was used as a token to confirm to James VI of Scotland—James I of Britain—the death of Queen Elizabeth.

See also MINERALS; Colour Plate opp. p. 288.

SARAWAK (BORNEO), *see* EAST INDIES.

SARDINIA. The Italian island of Sardinia lies 158 miles north of Tunisia, its north-east point, Aranci, being ten hours' sail from Italy (*see* Map, p. 160). 'Sardinia' probably comes from a Greek word meaning 'footprint', for the shape of the island is rather like the print of a bare foot. It is smaller than Sicily, being 160 miles long and 68 miles broad, and is relatively uproductive and scantily populated.

It is made up of blocks of high mountains, remnants of a submerged land that once stretched to the west. The mountains are highest on the east, where they overlook the Tyrrhenian Sea. In the north, the granite mass of Mt. Limbara rises to 4,468 feet. The highlands of the centre of the island are rugged and covered with brushwood and heather in which sheep and goats find poor pasture. In winter, snowdrifts make the mountain tracks impassable. Separated by depressions from these highlands are the almost inaccessible volcanic area of Nurra to the north-west and the rich mining area of Iglesias to the south-west, where lead and zinc have been mined since Roman times. In depressions between these mountain blocks are the plains of Sassari in the north and of Campidano in the south. They are fertile, but malarial, so that settlers seek higher levels. Along the south-west coast are sheltered bays such as Palmas, where Nelson anchored his fleet.

The lack of unity in the island has laid it open to attack, and Sardinia has been ruled in turn by Carthaginians, Romans, Vandals. Byzantines, Arabs, Pisans, and Genoese. Traces of these invasions still exist. Alghero, on the north-west coast, is like a Spanish village—and the people speak Catalan. Sassari was a colony of Pisa—and a dialect of Pisa is still spoken

CASTEL SARDO, A MEDIEVAL CASTLE ON THE COAST OF SARDINIA

Paul Popper

there. There are many local dialects, and pride of family and locality is strong.

Sardinia has been inhabited since earliest times: burial mounds of the Bronze Age have been unearthed. The people are of the 'Mediterranean' type, dark, with long heads and wavy hair. They have probably the shortest stature of any people in Europe. On the plains they live in small houses built of sun-dried mud, and use ox-wagons with solid wooden wheels. Their farming methods are primitive. Wheat is grown, but the yield is low. Flour is ground in old stone mills. Other products are olive oil and wine. As in all Mediterranean countries where summer means drought, irrigation is necessary, and in the farming districts there are curious water-wheels made of brushwood with earthenware pots, which are turned by blindfolded donkeys.

In the mountainous interior the people are even more backward. Few of them can read or write, and the most important person in the village is the priest. Huts are often of stone with a hole in the roof for chimney. In the mountain villages native costume is still worn, the men in white shirts and black embroidered jackets and trousers, the women in white blouses and black full skirts and jackets.

Cagliari, with a population of about 57,000, is the chief town and port of the island. It has an excellent harbour and the three main railways converge upon it.

Attempts are being made to develop the resources of Sardinia and to encourage the people to adopt modern methods of farming, fishing, and mining. New industries, such as the canning of tomatoes, are being introduced, whilst part of the Campidano has been drained and developed. It is planned to provide the area with irrigation and hydro-electric power by means of a great dam across the River Tirso.

SARGASSO SEA. In the days of sailing-ships fearful tales were told and believed of a great area in the North Atlantic where floating seaweed lay so thick on the surface that many ships had been caught and held until their crews died and their very timbers rotted away. COLUMBUS (q.v. Vol. V) brought back the first reports of the Sargasso Sea: his ship sailed through it for a fortnight, and the tales recounted by him and

his crew lost nothing in the telling. Actually there is such a region in the Atlantic, about midway between North Africa and America; but the weed is not thick enough to be a serious danger even to small sailing-ships.

If you place a few bits of straw in a bucket of water and then stir the water round and round, you will find that the floating straws move to the centre. This is what happens on a vastly greater scale to make the Sargasso Sea. The currents in the North Atlantic move clockwise in an enormous circle, with the Gulf Stream on the west and north, the Canaries Current on the east, and the North Equatorial Current on the south (*see* OCEANS). The prevailing winds blow in the same directions, especially in the summer (*see* WINDS, Fig. 4). And so, with the North Atlantic Ocean as with a bucket, most of the floating matter gradually makes its way to the middle. It consists mainly of a yellowish seaweed, called 'gulf-weed', which is believed to start its growth on the shallow bottom of the Caribbean Sea and Gulf of Mexico, in tropical waters, and then to become detached. That the Sargasso Sea must have existed through uncountable ages is suggested by the fact that the gulf-weed is inhabited by many strange forms of animal life found nowhere else in the world, all coloured like the weed for purposes of protection. The extent and position of the Sargasso varies considerably with changes of wind and current; but its average measurement is about 1,200 miles from east to west, and 400 from north to south. Similar, though smaller, areas of floating weed are found in other oceans.

SARK, *see* CHANNEL ISLES.

SATELLITES, *see* MOON; PLANETS; ECLIPSE.

SATURN, *see* PLANETS, Section 8.

SAVANNAH, *see* GRASSLANDS.

SAXONY, *see* GERMANY.

SCHLESWIG-HOLSTEIN. These two provinces lie in the south of the Danish peninsula (*see* Map, p. 124), and for many centuries were Danish duchies; but after a short war in 1864, both provinces were annexed by Prussia. As a result of a plebiscite after the First World War, north Schleswig returned to Denmark. The political frontier just north of Flensburg corresponds roughly with the Danish–German language boundary. Several islands are included in Schleswig-Holstein, the most important being Fehmarn in the Baltic, and Heligoland, Sylt, and Föhr in the North Sea. The Baltic coast has numerous long, narrow inlets which make excellent harbours. The KIEL CANAL (q.v. Vol. IV), which intersects Holstein, is the most direct route between the Baltic and the North Sea. Until the Second World War, when it was almost completely destroyed, the city of Kiel was a great seaport, and had large shipbuilding yards.

The country of both provinces is low-lying, much of it being marshland. The lowlands have been drained to make good agricultural and pasture-land—the well-known black and white Holstein cattle have been bred here and are reared for export. On the Baltic coast is a prosperous fishing industry.

See also DENMARK; GERMANY.

SCILLY ISLES. These are a cluster of little islands, granite rocks, and dangerous sunken ledges, lying some 30 miles south-west of Land's End in Cornwall, in the track of ships entering or leaving the mouth of the English Channel. St. Mary's, the largest island, 2½ miles long, is

PICKING DAFFODILS ON ST. MARY'S, THE LARGEST OF THE SCILLY ISLANDS
The Times

connected with Penzance by ship and plane. Four others, Tresco, St. Martin's, Bryher, and Agnes, are inhabited. There are three lighthouses to guide ships, especially liners from New York on the last stage of their journey.

The Scilly Isles are wrongly claimed to be the 'Tin Islands' of the PHOENICIANS, or to be remnants of the lost country of Lyonesse in the ARTHURIAN LEGEND (qq.v. Vol. I). They have many Stone Age remains, and traces of Roman occupation. In the Middle Ages Tresco had a small monastery; but the islands were kept poor by sea-robbers, and exposed to invaders of England—Vikings, French, Spanish, Dutch, and German. Queen Elizabeth fortified St. Mary's, which was garrisoned till 1863; and in the Civil Wars it was the last stronghold of the Royalists, surrendering to Cromwell's forces in 1651. The islands belong to the Crown and from 1571 to 1831 were leased by the Godolphin family. In 1834 they passed to Augustus Smith who made great improvements. Tresco and the uninhabited islands still remain in his family, while the rest are now administered as a royal estate by the Duchy of Cornwall.

Fishing, wrecking, salvage, smuggling, burning seaweed for its alkaline ash, building and manning wooden ships, pilotage, growing early potatoes—each has in turn supported and failed the Scillonians. But about 1880 they began to supply English cities with daffodils, which their climate is warm enough to produce by late winter, grown as they are in tiny fields sheltered from the strong winds by stone walls or evergreen hedges. In summer, visitors come to see the brilliant colouring of sea and shore, to go bathing, boating, and fishing, to visit uninhabited islets where sea-birds and grey seals breed, or the botanical gardens at Tresco where semi-tropical plants grow in the open.

The present inhabitants, mostly of English stock, are thrifty, independent, sociable, and able to turn their hands to many things. Though their prosperity now depends on flower-growing, they keep their old interest in ships, boats, the sea—and the drift it casts ashore.

SCOTLAND. The long-maintained independence of Scotland was partly due to her position at the north-west edge of Europe and to the fact that she is separated from England by the Cheviot Hills and the Southern Uplands, which made penetration from the south difficult. Independence was also made [illegible]ible by the fact that Scotland was able to be [illegible]ctically self-supporting. There were hills [illegible]h pastured sheep for food and wool, coastal [illegible]ins and fertile valleys where cereals and o[illegible] food crops as well as flax were grown and ca[illegible] reared, and there were safe harbours for fish[illegible] boats.

Scotland is made up of three [illegible] of country —Highlands, Midland Valley [illegible] Southern Uplands. A north-east to south[illegible] line from Stonehaven on the east coast to H[illegible]nsburgh on the Clyde marks roughly the s[illegible]ern edge of the Highlands. The western [illegible] the eastern Highlands differ considerably f[illegible]ach other. In the west high bare hills, 'bens' [illegible]steeply to a rugged coast of promontories [illegible] narrow sea lochs, and to deep U-shaped val[illegible] with lochs and sluggishly flowing rivers on t[illegible]r flat floors. These hills rise in irregular pe[illegible] and sharp ridges to over 3,000 feet abo[illegible]-level, Ben Nevis, the highest mountain in [illegible], reaching 4,406 feet. Two arcs of islands [illegible] HEBRIDES (q.v.), border the west coast. In t[illegible]ner arc the biggest islands are Islay, Jura, [illegible] Tiree and

SCOTLAND

A VILLAGE IN THE WESTERN ISLANDS OF SCOTLAND
J. Petrie

Coll, and Skye, the beauty of whose bare awesome peaks is world known. The outer arc, or Outer Hebrides, curves northward from Barra to Lewis in an intricate pattern of low hummocky land indented by branches of the sea. The only hills are in north Harris. To the north lie two groups of islands, the ORKNEYS, separated from the mainland by a narrow channel, and the SHETLANDS (qq.v.) some 50 miles beyond.

Cultivated land in the west Highlands is restricted to the floors of valleys and to narrow coastal plains. There, oats, potatoes, barley, turnips, and feeding stuff for cattle and sheep are grown. Sheep are pastured on the hills. In the last 150 years there has been a considerable amount of reafforestation, and timber may become a major industry in the future. The use of water-power for making electricity is being developed rapidly, and deposits of mica and other minerals are being worked. Large areas are kept as 'deer forests' for the sports of grouse-shooting and deer-stalking. These are the purple heather-clad moors and hills that are known in song and picture. For the most part the land brings in better profit to its owner in this way than it would if put to any other use.

The eastern Highlands are much less wild in character. Their summits are less rugged and rocky, and they fall to a coastal plain which backs a smooth coast-line broken only by the big estuaries of the Moray and Dornoch Firths. In the valleys and plains of the east Highlands cattle-rearing for beef is the main type of farming, and large quantities of hay and root-crops are grown accordingly. Round the towns there are orchards and market gardens.

The Midland Valley of Scotland, in contrast to the Highlands and the Southern Uplands, is densely peopled. It is a rather hilly plain, cut into by the Firths of Tay and Forth on the east and the Firth of Clyde in the west, and crossed parallel to its northern edge by a chain of hills rising to almost 2,000 feet. A second chain of hills, of which the Pentland Hills south of Edinburgh are the most distinct, runs parallel near the southern edge of the lowland. Between these chains of hills are isolated volcanic hills which rise abruptly from the plain. The hills are for

KIRKCUDBRIGHT, IN SOUTH-WEST SCOTLAND
The Scotsman

the most part bare and grassy, though there are heather and bracken areas.

The eastern part of the Midland Valley is very fertile. Oats, barley, turnips, and potatoes are grown in the north, while in the Tay valley are rich meadows and orchards and fields of raspberries and gooseberries. South of the Firth of Forth, wheat and barley give higher yields per acre than anywhere else in Britain. The western part of the valley is highly industrialized, but where there is agricultural land it is very fertile. Dairy cattle are important, and fodder crops and fruit are grown intensively.

The Midland Valley holds the mineral wealth of Scotland. There are coal-fields in the east on both sides of the Firth of Forth, and coal-fields associated with iron in the west. Oil shale is mined on the south bank of the Forth.

The Southern Uplands are very different from the Highlands. The hills are much lower, seldom rising over 1,900 feet above sea-level, and have in general broad rounded slopes covered with heather and peat moor. In the west, a mild climate with heavy rain, especially in autumn, makes dairy-farming and cattle-fattening the most profitable type of agriculture. In the Tweed valley in the east, between the Southern Uplands and the Cheviots, the climate is much drier. Cereals, potatoes, and turnips are grown on the fertile valley soils, and sheep are pastured on the hills. The wool is used in a very long-established woollen industry centred in towns in the Tweed valley.

Of the four big cities of Scotland three are in the Midland Valley. EDINBURGH (q.v.), the capital, is on the south side of the Firth of Forth. GLASGOW (q.v.), Scotland's largest city and the third largest in the British Isles, is on the Clyde. Dundee, the fourth largest city in Scotland, is on the north bank of the Firth of Tay and is the centre of linen and jute manufacture, as well as other manufactures including marmalade (the first marmalade came from Dundee). Aberdeen, the third biggest city in Scotland, lies on the east coast of the Highlands, commanding two river valleys. It is an important fishing port. Scotland used to be a land of small farmers—crofters as they were called in the north-west.

Now, much the majority of her people live in the cities.

See also Vol. I: Scots.

SEASONS, *see* Earth.

SENEGAL, *see* Guinea Lands.

SERBIA, *see* Yugoslavia.

SEYCHELLES, *see* Indian Ocean Islands.

SHALE, *see* Clays and Shales.

SHANGHAI. In 1842, after the Anglo-Chinese War, China—who till then had resisted foreign trade—opened a number of places on her coasts as 'Treaty Ports' where foreign merchants could settle and live in their own way under their own laws. Of these, Shanghai was the most important. Two foreign-controlled areas, the International Settlement (the more important of the two) and the French Concession, grew up in Shanghai adjoining the old Chinese City. The Chinese are developing as a great municipal area a belt of some 320 square miles round the city. Foreign capital, organization, and enterprise helped to make Shanghai one of the world's greatest commercial ports, handling more than half the trade of China, and now the fifth largest city in the world with a population of slightly over 3½ millions. Foreign capital also helped to develop Shanghai's manufacturing industries, which employ half a million or more workers.

The International Settlement was an outstanding example of a self-governing, practically independent city. It elected its own Municipal Council, which managed all its affairs, and sometimes acted independently of the Chinese Government or indeed of any other Government. It even had its own little army, the 'Shanghai Volunteer Corps'. However, after the Second World War, Great Britain and the United States gave up their special treaty rights, and left China free to take over control of the whole settlement. Of the foreign community of nearly 50,000, many were business-men, employed by British firms, but many were educationalists or doctors—for Shanghai was proud of its schools and hospitals, although they were inadequate to deal with the great Chinese population of the International Settlement. Over a million Chinese lived there—the number being so great because it had served as a sanctuary for refugees during many periods of civil war.

Shanghai lies some way up a broad creek which runs into the Yangtze estuary (*see* Map, p. 87), and the waterfront presents a panorama of fine and impressive buildings, some of which

THE WHANGPOO RIVER AT SHANGHAI
The Whangpoo is a tributary of the Yangtze. *Paul Popper*

are fifteen storeys high. Their erection has been a triumph of engineering, for the buildings stand —or rather float, as they are built on 'rafts'— on bottomless Yangtze mud, and consequently do not have solid foundations.

See also CHINA.

SHANNON. This Irish river is 240 miles long including the estuary, and the longest river in the British Isles. It rises at the foot of Mt. Guilcagh in Co. Cavan, very near the border between Northern Ireland and Eire (Irish Free State). It crosses Co. Leitrim, and is the boundary between Co. Roscommon on the west and the counties of Leitrim, Longford, West Meath, and Offaly on the east. In its lower reaches, Galway and Clare are to the west and north, Tipperary and Limerick to the east and south. When the Shannon finally reaches the Atlantic, at what is almost the most westerly point of Europe, its southern bank is in Co. Kerry. Eleven of the twenty-six counties that make up the Republic of Ireland are drained by it (*see* Map, p. 236).

The Shannon passes through a number of lakes, of which Loughs Allen, Ree, and Derg (24 miles long) are the largest, [illegible] joined by many tributaries. It can be na[illegible]d by large ships as far as Limerick, by sm[illegible] steamers as far as Athlone, by still smaller [illegible] to Lough Allen, and is connected by ca[illegible]th Dublin and the east coast. In ancient da[illegible] Shannon was one of the main routeways [illegible]land: on its banks, and on the islands in th[illegible]s through which it passes, there are ma[illegible]es of old civilizations and of more recent [illegible]ous settlements.

The waters of the Shannon, [illegible]amous for their salmon, are used now to [illegible] electric power to light towns and driv[illegible]ries. The power-station, from which grea[illegible]lons carry electricity to the rest of Irelan[illegible]at Ardnacrusha, just north of the city of [illegible]ick.

The salmon, so long the lords [illegible] Shannon, have not been forgotten: beside [illegible] great dam that holds back the Shannon w[illegible] there is a special passage called a fish-ladd[illegible] which the salmon can still get to the upp[illegible]ers of the river to lay their eggs, as they [illegible]done since long before there were any men [illegible]n Ireland.

The Shannon, at its mouth, [illegible]ls into an estuary of 60 miles in length, [illegible] the port of

THE SHANNON AT KILLALOE, CO. CLARE. *Irish Tourist Association*

FLADDABISTER, NEAR LERWICK, SHETLAND ISLANDS
Jack Linklater

Limerick at its head. This estuary, now known as Shannon Port, is the terminus of one of the principal transatlantic airlines.

See also IRELAND.

SHETLAND ISLANDS (or ZETLAND). These islands, though lying far to the north-east, some 50 miles beyond the ORKNEY ISLANDS (q.v.), are a county of Scotland. Of the hundred islands and islets of the group twenty-seven are inhabited. Mainland, Yell, and Unst are the largest. For long the islands were under Norse domination, and even to-day many of the inhabitants think of themselves as more akin to the Faroese and the Norwegians than to the Scots.

The islands are hilly and rocky. Roeness, the highest point, rising to 1,447 feet, is on Mainland. The steep coasts have some of the most magnificent scenery in Britain. On Mainland, near Lerwick, the huge Cave of Bressay is reached by boat through an outer cave and a curving channel. The cave has magnificent stalactites and stalagmites. Equally wonderful are the caves of Papa Stour, which have walls of pinkish porphyry, covered with trails of vivid seaweeds, and glistening with mica (*see* CAVES). The 580-foot high precipice of the Noup of Noss is the nesting-place of gulls, kittiwakes, guillemots, and puffins. Near the north point of Unst—the most northerly point of the British Isles—the famous lighthouse of Muckle Flugga throws a light, 260 feet above the sea, which is visible for 21 miles. Beyond Unst the sea stretches to the ice of the Arctic Ocean.

The Shetlanders are for the most part fishermen who also work small crofts and keep sheep. The land is barren and rocky, treeless, and practically without running water. Much of the work on the crofts is done by the women, who also are responsible for the islands' second important industry, the knitting of woollen goods and weaving of cloth.

Lerwick, the capital of the Shetland Islands, is on Mainland. It is an important port of the herring fleets of Britain.

The island of Foula lies about 30 miles west of the Shetlands. Its west coast rises in huge cliffs and precipices on an average some 1,200 feet above the sea which has here a depth of some fourteen fathoms. These cliffs are nesting-places of countless sea-birds.

See also SCOTLAND.

SHOOTING STARS, *see* METEORS.

SIAM (or THAILAND). Siam lies at the head of the Gulf of Siam, a large bay opening northward off the South China Sea, and continues south in a long strip down the east of the peninsula which ends in Malaya and which separates the Bay of Bengal from the South China Sea (*see* Map, p. 87). Burma to the west and French Indo-China to the east meet to the north of Siam. The main part of Siam has a maximum length and breadth of about 500 miles. The long peninsular strip is about another 500 miles long.

In the north are the foot-hills of the great mountainous region of Tibet and western China. They are covered by dense forests penetrated by only a few roads, though in recent years Europeans have begun to fell the valuable timber there and to float it down to the sea by the rivers. The Siamese use an interesting device to get over the difficulty that a newly-cut log of teak is too heavy to float: they cut a deep ridge round the trunk some time before the tree is felled; this kills the tree, which dries out gradually so that when it is felled it is light enough to float. Elephants are used to push and pull the heavy logs to the rivers' banks.

HOUSEBOATS ON THE RIVER MENAM, SIAM
Paul Popper

From these northern mountains a range stretches down the west side of Siam and along part of the peninsular strip. This range is covered with dense tropical forest and forms a difficult barrier between Siam and Burma. To the east lies the lowland of Siam, a rich plain crossed by many rivers and canals and producing most of the rice of Siam. So great is the rice crop that large quantities are exported. The rice-fields (paddy-fields) are kept flooded while the crop is growing, so that at this season of the year the plain looks like an immense lake crossed by low earthen walls, built to keep the water from draining away. Near the mouth of the main river stands BANGKOK (q.v.), the capital. East of the plain there are plateaux which are cultivated but are much less fertile and [illegible].

The lower areas of peninsular Siam are noted for their rich deposits of tin and wolfram. Much of the tin-ore lies on or near the surface and is mined by huge mechanical dredgers which scoop up the soil by a moving chain of buckets. The buckets are tipped into the machine, which then extracts the ore and ejects the waste behind it as it moves forward. These dredgers float in a 'tank' which they cut out as they advance and then fill in with the waste. Abandoned 'tanks' are a feature of the region.

In the hills, population is sparse and scattered in primitive settlements. The fertile lowland is densely peopled; but the only large town in Siam is Bangkok. The total population of the country is about seventeen millions.

See also Vol. I: SIAMESE.

SIBERIA, *see* R.S.F.S.R., Section 5.

SICILY. This is the largest island in the Mediterranean Sea—a little larger than Wales. It is separated from Italy by the Straits of Messina which are 2 miles wide (*see* Map, p. 160). In these straits are reputed to be the famous Scylla and Charybdis of Greek legend. According to the legend, if sailors succeeded in

SICILY: LOOKING SOUTH FROM MONREALE. *R. Gardner*

avoiding the monster Scylla on her rock, they were sucked to destruction by the whirlpool Charybdis (*see* MYTHOLOGICAL MONSTERS, Vol. I).

Sicily is for the most part a mountainous country. A ridge of high mountains along its northern side drops northwards steeply to the sea or to a narrow coastal plain, and southwards much less steeply to the hilly and mountainous country of central Sicily. The volcano of ETNA (q.v.), on the east coast, towers above the other mountains, rising to 10,740 feet in a cone which is snow-capped in winter. South of Etna lies the almost treeless plain of Catania, the largest plain in Sicily, in which is situated the second largest city and main port, Catania. The plain is crossed by three rivers, and drainage ditches have turned much of it from marsh into pasture land. In the south-east of the island are plateaux mainly of white and yellowish limestone, cut by deep river gorges and covered by rather poor pasture. Where the limestone is capped by volcanic rocks there is fertile soil, on which fruit-trees, almond trees, and vines are grown. Most of the rest of the country consists of limestone hills and mountains with small plains and terraced fields round the coast. Along part of the west coast are salt-pans with their dazzling mounds of salt. Little forest remains in Sicily, the greater part of the island being cultivated. Round the west, north, and east coasts a great variety of fruits are grown, as well as mulberry-trees—often on terraced hill-slopes. In the west, round Marsala, vineyards occupy almost the whole area.

The Egadi Islands, which lie off the west coast, are of limestone and are bounded by steep cliffs. Ustica and the Lipari Islands, off the north coast, are volcanic. They include Vulcano and also Stromboli, the most continuously active volcano in Europe, which rises about 3,000 feet. Stromboli, according to ancient fable, was supposed to be the abode of Aeolus, ruler of the winds, and in the Middle Ages was thought of as the entrance to Purgatory.

Sicily has a very ancient and stormy history. Her interest to visitors nowadays is perhaps principally because of her wealth of magnificent monuments, both of classical and medieval times. Her lovely climate, however, and some very beautiful scenery, especially the coastal scenery round Taormina on the east coast, also draw many visitors to the island. Sicily has been colonized and fought over from many centuries

before Christ, by Phoenicians and Greeks, by Carthaginians and Romans, and by Byzantines, Saracens, Normans, and powerful lords of France, Germany, and Spain—until Garibaldi brought her into a united kingdom of Italy in the 19th century. Even then brigands still ravaged the country until Mussolini succeeded in clearing them out and restoring order.

The most important Greek city was the port, Syracuse, on the south-east. It was founded in 734 B.C., and was far-renowned for its wealth and power. Its Greek theatre, cut out of the solid rock, is one of the finest in existence. Greek plays are still sometimes performed in it. The next largest Greek city in Sicily, Girgenti (known to the Greeks as Akragas and to the Romans as Agrigentum), had in those days a population of nearly a quarter of a million, and carried on tremendously profitable trade with the Carthaginians. Girgenti has one of the best preserved Doric temples in existence.

Sicily's biggest city, Palermo, was founded by the Phoenicians. Its interest now lies particularly in its magnificent medieval buildings—the 12th-century cathedral built by the Norman Sicilians, the church and cloisters of S. Giovanni, and in particular the magnificent cathedral and cloisters at Monreale, a few miles away from Palermo. This cathedral, built in 1174, has some of the most lovely glass mosaics to be seen anywhere in the world.

Until very recently, Sicily has been one of the poorest and most backward parts of Italy. Her people suffered from the ill-treatment of feudal lords on the one hand and the attacks of brigands on the other. Because of need for protection, the people lived in large villages or small towns often built on flat hill-tops or on rocky platforms along the coast. Many of the towns have remains of Norman or Saracen castles, built on strategically powerful positions on hills.

See also ITALY.

SIERRA LEONE, *see* GUINEA LANDS.

SI-KIANG. The Si-Kiang (West River) is one of the three great rivers of China. It rises in eastern Yunnan, not far from the BURMA ROAD (q.v. Vol. IV), and flows eastwards to empty itself in the South China Sea. It is much shorter than the YANGTZE KIANG or the YELLOW RIVER (Hwang-Ho) (qq.v.), but is important for two reasons: it provides a gateway to the sea for the otherwise inaccessible regions of south-west China; and its wide delta produces a livelihood for one of the densest populations in China, or indeed in the world. Hundreds of thousands of families spend their entire lives afloat on the water-ways. Less innocent are the hordes of pirates who harbour their craft in its creeks, and make the river and the seas around Hong Kong the worst pirate-ground in the world.

Largish steamers, heavily barred and armed against attack by the pirates, sail 200 miles up the river to Wuchow, the chief trading centre of this part of the south-west. A peculiar feature of Wuchow is that houses and shops are built on floating pontoons, so that they rise and fall with the great changes in river-level. Smaller steamers can reach as far as Yungning, the capital of the province of Kwangsi.

CANTON (q.v.) lies on the northern edge of the delta, and is connected to the sea by a branch of the Si-Kiang known as the Pearl River.

See also CHINA.

SILESIA, *see* POLAND.

SILVER, *see* METAL ORES; *see also* Vol. VII: SILVER-MINING.

SINGAPORE. The island of Singapore, at the extreme south of MALAYA (q.v.), is probably the most important centre of air and sea communication in the Far East, and is a sort of junction point between the Indian and Pacific Oceans (*see* Map, p. 21). It is about the size and shape of the Isle of Wight, and is connected to the mainland at Johore Bahru by a causeway about a mile long, which carries a road and railway. Singapore town lies on the south side of the island. It has a large dock and a roadstead able to take up to fifty ships riding at anchor.

Singapore is essentially a new town. In February 1819 the island was occupied by Sir Stamford RAFFLES (q.v. Vol. V). At this time much of the land where the town now stands was an uninhabited swamp; but the position was of such importance, and Malaya, as a country, became so prosperous that the town grew quickly. Among the big blocks of office buildings, cinemas, and shops, of peculiar interest are the sky-scraper Cathay buildings, the Raffles Hotel, and the quiet, rubber-panelled railway station. There is now a population of about half a million, two-thirds of whom

A STREET IN THE CHINESE QUARTER OF SINGAPORE
B.O.A.C.

are Chinese. The streets in the Chinese quarter are mostly narrow, smelly, and full of small shops, selling nothing in particular. There is a large dock area, the vast floating dock for which was built in Britain and towed out to Singapore. The excellent airfield at Tanjong Katong, an enormous circular field, is on the outskirts of the town. Altogether, Singapore is a busy, rich city, with a reputation for gaiety.

The island itself is prosperous, with many small villages and plantations worked by the Chinese, who can generally get good prices for their products in the town. At the north, near the Causeway, is the large naval base at Seletar.

See also East Indies.

SINKIANG, *see* China.

SIROCCO. This is a hot wind drawn northward across the Mediterranean Sea by a low-pressure system or cyclonic disturbance passing from west to east (*see* Weather). Its great heat comes from the north African desert, and in Algiers it is hot, dry, and often dust-laden; but by the time it reaches Sicily and Italy it has picked up water-vapour from the Mediterranean, and is particularly unpleasant in its heat and humidity.

See Winds.

SKYE, *see* Hebrides.

SLATE, *see* Rocks, Section 4.

SLEET, *see* Snow.

SLOVAKIA, *see* Czechoslovakia.

SLOVENIA, *see* Yugoslavia.

SNOW. When an excess of moisture in the air is condensed straight from its gaseous form as Water-vapour (q.v.) to ice, the crystals formed are known as snow. In this respect snow differs from Hail (q.v.), which is frozen rain. Snow crystals, like other crystals, are geometric in form. They are all six-sided, but in other ways they differ very widely. W. A. Bentley, who devoted a lifetime to studying and photographing snow crystals, had nearly 6,000 negatives, no two of which were the same. The crystals vary in size, their thickness being generally about one-tenth of their width, which varies from $\frac{1}{100}$ to $\frac{1}{4}$ of an inch.

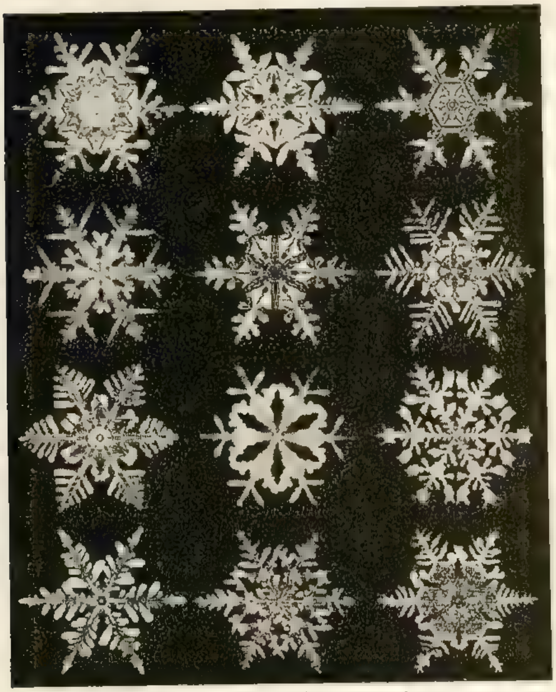
A snow-flake is a bunch of snow crystals stuck together by having partly thawed and then refrozen. Flakes occur, therefore, when the temperature is not very far from freezing-point. Sometimes a number of snow-flakes stick together and form an out-size flake or 'aggregate', which may be as large as a saucer. Sleet is partly-thawed snow, and is usually accompanied by rain or snow.

When snow first falls, it covers the ground in a blanket which contains a very large proportion of air. It is this air which allows men and sheep, buried in drifts, to survive for quite a long time. A foot of newly fallen snow is estimated to contain about as much water as an inch of rain, though this varies according to atmospheric conditions.

Although snow is one of the most delicate and fragile of substances, in certain circumstances it causes great danger and destruction, as is proved by records of snow-storms, blizzards, and Avalanches (q.v.). Immense quantities of snow may fall during a heavy snow-storm. On 16 February 1929 snow fell over a small area of Dartmoor to a depth of 6 feet—and there was no drifting to account for this depth. In 1934, during a widespread snow-storm, snow 8 feet deep was reported in Maine in the U.S.A.; and in another area the Canadian National Railway

had to borrow extra snow-ploughs to dig out 200 miles of line. One train was completely buried, and areas of snow 15 feet deep were reported.

Blizzard is not another name for snow-storm: a blizzard is a strong wind blowing during very



SNOW CRYSTALS (MAGNIFIED)
From *'Snow Crystals' by W. A. Bentley & W. J. Humphreys. (Publ. McGraw-Hill, N.Y.)*

cold weather and carrying masses of drifting powdery snow. Any other type of heavy snowfall is a snow-storm. Blizzards are rare in this country; but they often sweep across the great northern plains of the U.S.A. With a temperature perhaps as low as 10 to 20 degrees below zero, violent winds from the north drive clouds of dust-like snow before them. During a great blizzard in Dakota in 1873, the wind blew for four days and nights in some areas, and for much of the time had a speed of about 50 miles per hour. Many people were badly frozen, and large numbers of cattle were frozen to death. In these blinding storms visibility is reduced to a few feet, and people have been known to perish only a few yards from a house, not knowing it was there.

Snow is not solely destructive, however. When pressed into ice or melted into streams it helps to wear down rocks into soil (*see* DENUDATION). A blanket of snow keeps seeds from being frozen to death in very cold weather. And in mountain areas it forms a valuable reserve of water released gradually as it melts in spring and summer. Such water is often used for irrigation or in hydro-electric schemes.

SOFIA. Until the freeing of Bulgaria from Turkish rule in 1877–8, Sofia was a purely Turkish town, in which the only fine buildings were the houses of the *beys* and *pashas* (Turkish governors). The Bulgarians lived in abject poverty in a crowded Christian quarter grouped round the church of St. Nedelia. Sofia was an important trading and route centre, crowded with resting places for caravans between Belgrade and Constantinople (Istanbul), for it is situated in a plain in the midst of the mountains of the Balkans at a place convenient for routes from the Struma and Isker valleys. To-day it is on the railway which carries the Orient Express from Vienna to Istanbul.

In 1880 the work of rebuilding the city was begun. The old Turkish town with its mosques and narrow streets was swept away. A new city of broad boulevards, open spaces, and wide streets laid out in squares has been built. In the centre are the palace and government buildings, the cathedral of St. Nedelia, and the great church of St. Alexander Nevsky, built as a memorial to the Russians who fell in the liberation of Bulgaria. This church is a rather handsome Byzantine building with modern mosaics and gilded cupolas.

Open-air markets are held in the city, and bargaining is oriental in its keenness. Wooden articles, wool, cloth, and fruit of many kinds are the chief things sold.

See also BULGARIA.
See also Vol. I: BULGARIANS.

SOIL EROSION. Erosion, the gnawing away of soil and rocks by natural forces, is one of the processes of DENUDATION (q.v.), itself part of the cycle by which the face of the earth is continually changed.

From the point of view of human life, it is calamitous if soil is removed completely from hundreds of square miles of cultivable land, for soil is the living mantle which makes plant life and animal life possible. In it there is a world which, in many years of work by plants and animals, converts rock dust into soil. In it there are organisms of microscopic size which work

SOIL EROSION IN THE TENNESSEE VALLEY
Tennessee Valley Authority

upon the corpses of large animals and plants, and there are the living bodies and eggs and larvae of vast numbers of insects, spiders, ants, centipedes, millipedes, worms, and other invertebrates (*see* SOILS, Vol. VI). And so it is important that soil should not be wasted or allowed to blow away from the earth's surface. Yet that is precisely what has been happening over vast areas of the earth, especially during the last hundred years. In their search for land to cultivate, men of all races have cut down trees and farmed the land in places where rain or wind or both are too strong for unprotected soil to resist their force. Without the protection from sun, wind, and rain which trees give, the soil has been carried away into rivers and washed into the sea—leaving bare uncultivable rock in its place.

This happened in the Tennessee valley of U.S.A. The rainfall there is over 50 inches per year, which means that 5,000 tons of water fall on each acre every year. When the trees had been removed, with their sheltering leaves and branches, and their anchoring roots, thousands of square miles of country lost their soil and became completely derelict.

There are serious soil erosion problems in many areas of Africa. In parts of West Africa, such as northern Nigeria, the wholesale cutting down of trees has resulted in a reduction of rainfall in the deforested region, as it so often does, and the soil has become parched and shrivelled in the sun, so that its dried particles have been blown away, leaving only desert behind. In East Africa, the settled conditions imposed by white rule have enabled the population to increase. The herds of cattle have increased also, and to such an extent that pasture over many hundreds of square miles has been eaten away. Sun, wind, and rain have not lost their opportunity and have carried the exposed soil away. Now only bare useless rock remains. In other parts of East Africa, the natives used to clear land for cultivation by burning down an

area of 'bush'—knowing that the soil there would be fertile. When they had taken crops from it for a few years, without replacing any of the organic material used from the soil, they would strike camp and move to a new spot, where again they would burn down the 'bush'. Too often the exposed soil left behind was carried away by wind or water before a new cover of plants could establish itself.

In other parts of the world, too, the unwise greedy action of men has turned fertile land to desert. To bring about the destruction is easy—so easy that it is generally done unknowingly; but to restore fertility to a barren land is often impossible or nearly so. In several parts of the world, however, successful efforts have been made. The work of the Tennessee Valley Authority has shown the world what can be done when a great number of scientists, inspired with a great vision, work together to tackle a gigantic problem in a gigantic way. Enormous dams have been built to hold back flood-waters for irrigation and for the generation of cheap electric power; hills have been levelled or terraced, and planted with special plants that have restarted the conversion of rock dust into soil; tree planting has followed; lakes have been colonized with fish; minerals have been mined for fertilizers, and semi-fertile soil has been treated with chemicals to improve its fertility; new plants specially adapted to the soil have been introduced to the area; villages and towns have been built; housing, education, health, recreations, and farming have all been improved out of all recognition. In short, a poverty-stricken derelict area has become one of the most flourishing and materially advanced in the world (*see* UNITED STATES OF AMERICA).

While the Tennessee valley is by far the best-known area of reclamation, much excellent work has been done in other parts of the world. In Cyprus the British Government has sponsored and helped to carry out a scheme in which dams have been built and hill-sides terraced and planted with trees. In Africa attempts are being made to recover the devastated areas by planting trees. Jewish settlers in Palestine have performed what appears almost miraculous work in bringing desert areas under cultivation.

The problem of soil erosion, however, should be a problem not entirely of reclamation and recovery but, even more, of prevention and conservation. This aspect is now being studied, and new methods of farming are being worked out, suitable for dry areas—such as the 'dry farming' technique of parts of the U.S.A. Elsewhere, trees are being planted in threatened areas.

See also DENUDATION.

SOLAR SYSTEM, *see* ASTRONOMY, MODERN.

SOLOMON ISLANDS, *see* PACIFIC ISLANDS; *see also* Vol. I: MELANESIANS.

SOLSTICE, *see* ASTRONOMY, MODERN, Section 4.

SOMALILAND. South of the Gulf of Aden, Africa juts out in a great triangular promontory, with a north shore of about 600 miles and a south-eastern shore of about 1,000 miles. Somaliland occupies all of this promontory, except for the area of the Abyssinian Highlands which juts into it from the west. Kenya lies to the south-west (*see* Map, p. 5).

Along the north coast, desert plains rise by steep cliffed ridges to the red sandstone hills of the Somaliland plateau, 3,000 feet above sea-level. The plateau falls southwards to the basin of the River Juba; the Abyssinian Highlands rise to the west. It is dry arid country, with barely enough rainfall to provide water and food for the herds of cattle, camels, sheep, and goats which roam across it.

The Juba is the only permanent river, and it is navigable during the flood seasons—from May to early August and from December to the end of January. Its waters are used for irrigation on both banks of its lower course, where cotton, limes, oranges, and beans are cultivated successfully. Near the mouth, maize and rice are grown.

The few towns are along the coast. Inland there is hardly any permanent settlement. French Somaliland is a small area in the north, at the west end of the Gulf of Aden. Its port of Jibuti (Djibouti) has a good harbour and is connected by rail with Addis Ababa, the capital of Abyssinia. British Somaliland lies to the east and borders the north coast for about 400 miles. Berbera, with a population of about 20,000, is the chief town. It has a good harbour and is the starting-point for camel caravans to the interior. Hides and sheepskins are the chief exports. Italian Somaliland stretches along the whole east

THE MAIN STREET OF JIBUTI, FRENCH SOMALILAND
Paul Popper

coast and is by far the largest part. Mogadishu, its capital and chief port, is about 250 miles north-east of the mouth of the Juba River. There is no harbour, and ships anchor off shore.

The native population, the Somalis, are a fine type of NEGRO AFRICANS (q.v. Vol. I), mainly a pastoral people.

SOUND. This word has two main meanings: the impression our brain receives when the mechanism of the ear is set working, and the outside cause for this happening. Sound is caused by vibrations; but, unlike light (which, as we know, can travel through empty space), sound-waves must travel through some material substance if they are to reach our ears. Usually this medium is air, because our ear-drums are open to the air; but other substances will serve—as we can tell by tapping the side of a bath with our ears beneath the water, or by tapping a table fork or ruler gripped between the teeth, when the bones of the head will transmit the sound. But if an electric bell is set ringing in a glass jar from out of which the air is being sucked, the sound becomes fainter and fainter until, when the vacuum is practically complete, it cannot be heard at all.

Just as waves of water bounce back or are reflected from any smooth surface they strike against (as may be seen by watching the surge of the sea against a flat breakwater), or as light is reflected from the surface of a mirror, so sound-waves are reflected or 'echoed' back from a cliff or any suitable object. Ear-trumpets and the large ears of many animals make use of this property by collecting sound and reflecting it from side to side until it reaches the ear-channel. Conversely, a megaphone or the horn of a gramophone gains its effect by reflecting a large proportion of the sound into the desired direction.

In one respect it is rather misleading to think of the tiny, very rapid vibrations of sound as waves, though so long as we remember the following important difference, this is the simplest and most convenient way to picture them: waves on the sea move up and down across the direction in which they travel, whereas waves of sound move backwards and forwards along their line of travel. An easy way to think of this is to imagine a shunting engine giving one sudden push to a line of stationary goods wagons. As the first wagon is pushed away from the engine, it compresses the buffer springs of the next wagon. These give it a push back, so that it eventually comes to rest again. The second wagon then pushes the third, which acts in the same way, pushing the fourth—and so on to the next and next. Thus we can see a wave of depression moving right along the train, each wagon banging to and fro along the line of the wave's travel yet in the end hardly changing its own position. That is how the molecules of the air behave when they carry waves of sound to our ears. The distance which they move in banging to and fro is almost unbelievably small. If they move only one four-millionth of the thickness of a silk fibre (not a silk thread, but the fine fibres of which it is spun), we can hear a sound, provided they repeat it a suitable number of times per second. The speed at which the wave of expansion and contraction passes along the train of air molecules (the speed, that is, of sound in air) is 1,120 feet per second, or about 760 miles per hour. This is the figure for air at 16° C.: it varies slightly according to the temperature.

Since light travels so fast (186,000 miles per second) that we may usually consider its departure and arrival simultaneous, we can often judge the distance between ourselves and various happenings by noting the difference in time

between our seeing them and hearing them. The easiest way to do this is to practise counting at the rate of 11 in 3 seconds. For instance, if we start counting at this rate immediately we see a flash of lightning, the number we have reached when we hear the thunder will be the distance of the flash in hundreds of yards. In war, the position of enemy guns is often plotted in a similar way by watching for the flash and then listening for the report. In aviation, speeds higher than 760 m.p.h. are called 'supersonic', and the time has now come when aircraft can reach them (*see* SUPERSONIC FLIGHT, Vol. IV), although just at the critical speed of sound very

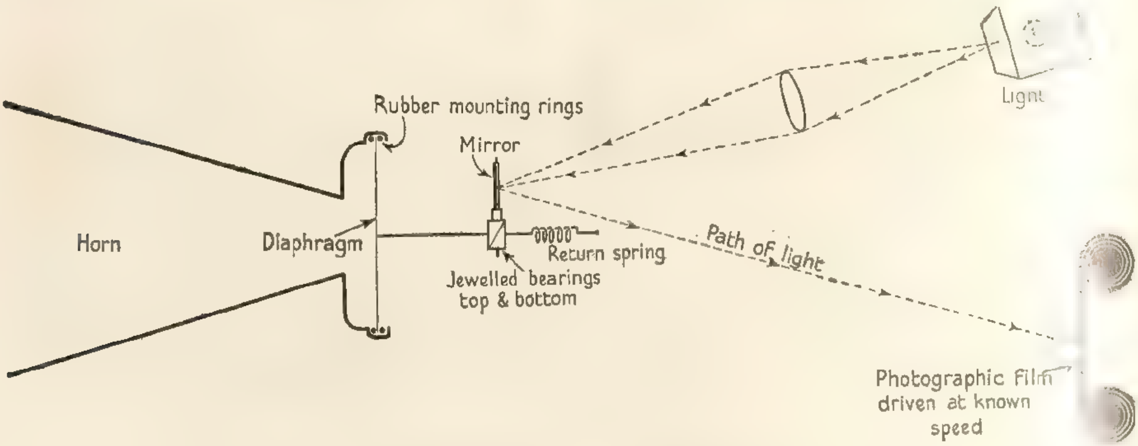


FIG. 1. A SIMPLE METHOD OF RECORDING SOUND WAVES

peculiar difficulties are met with. Through water sound travels more than four times as fast—at 4,800 feet per second. Sailors use this figure in taking soundings more quickly and accurately than can be done with a lead. Waves of sound are sent from the ship down through the water. When they strike the sea bottom, they are echoed back to the listening apparatus in the ship. From the time they have taken to do the double journey, the depth of the sea is calculated.

Wave-motion of any kind (and it should be remembered that such very different things as light, heat, and wireless all travel in waves) has a number of characteristic properties. These are described more fully in the article WAVE-MOTION. Here it is enough to say that sound has three main characteristics: (i) its 'pitch'—whether its note is high or low, (ii) its 'intensity'—whether it is loud or soft, and (iii) its quality, 'timbre' or character. As to the last we can make a rough division into musical and unmusical sounds; but even with musical sounds there is an obvious difference in quality between, say, the note middle C when played on a violin and when played on a penny whistle. Since all these characteristics are conveyed by sound-waves, we should expect an examination of the waves to give us a fair idea of differences in pitch, intensity, and quality.

There are several ways in which sound-waves can be made to draw enlarged pictures of themselves. In one of the simplest, they are allowed to strike against a thin, light plate or diaphragm, so mounted that it can vibrate when they hit it. (This is in effect how the ear-drum works.) The centre of the diaphragm is connected to a small mirror which moves as the diaphragm moves (Fig. 1). A spot of bright light is focused upon the mirror, from which it is reflected on to a strip of photographic film. Any vibration of the diaphragm therefore causes the spot of light to dance to and fro across the film, the movement being magnified about 40,000 times. If the film is then moved at a steady speed, so long as there is silence a straight line will be recorded; but as soon as any sound is allowed to vibrate the diaphragm, the line becomes wavy (*see* Fig. 3). Now let us see what can be discovered from such pictures of sound-waves. In the first place, as we might expect, the louder the sound, the bigger are the waves from crest to trough; or, as it is put, the intensity of a sound is determined by the 'amplitude'—this being the distance which a molecule travels from its position of rest when

displaced by a sound-wave (Fig. 2). How very small this may be even when compared with less than a hair's breadth we have already seen, and we may wonder then how small is the

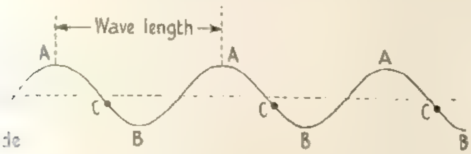


FIG. 2

amount of energy required to give rise to a sound. One answer is that if an insect one ten-thousandth the weight of a mosquito were to dance up and down on the ear-drum, provided that it danced at a suitable speed, a sound would be heard. At the other extreme, sounds can be too loud—the amplitude (or intensity) too great —for us to hear them. In such cases the sound is felt rather than heard. Next, it is found that the waves of a musical sound are more or less regular, like the waves of the sea; but that those of an unmusical noise have no clear pattern (*see* Figs. 3 *a* and *b*). In either case, the higher the pitch of the note or noise, the closer together are the waves; the lower the pitch, the farther they are apart. In other words, the pitch is determined by the 'frequency'—that is, by the number of vibrations or 'cycles' in a given time—whatever the source of the sound.

Just as amplitude must be within certain limits if any sound is to be heard, so our ears can react to certain frequencies only: sounds may be either too high or too low to be heard. With human ears, the limits are from about 20 c.p.s. (cycles per second) to 20,000 c.p.s. at the most suitable intensities. The limits vary much with different individuals: some people cannot hear the squeak of a bat, which is very high; to others it is easily audible. In general, children can hear much higher notes than adults, and old people are less sensitive still. Many animals can hear higher notes again—and whistles can be bought which make no sound audible to human ears, but which dogs can hear quite easily.

Finally, we come to quality or timbre. If we look at the sea on a stormy day, we can see on the sides and in the troughs of the billows themselves, a pattern of smaller waves—and perhaps in these again, yet smaller ripples. The same thing is true of sound-waves. It is, in fact, impossible to produce from any ordinary musical instrument a sound so pure that it draws an absolutely simple wave like that in Fig. 2. There are always waves of higher frequency (i.e. closer together) as in Fig. 3 *a*, and sometimes waves of lower frequency too. They are particularly noticeable in the sound of church bells. The note of the main wave is called the 'fundamental' or 'first harmonic', and is the one we refer to when we name a note in music—as, for instance middle C or [music notation]. The notes above it are called overtones, most of them being the second and later harmonics; and the general

FIG. 3. THE WAVE PATTERN OF (*a*) A MUSICAL SOUND AND (*b*) AN UNMUSICAL SOUND

name for all the tones sounded by the one note is 'partials', each of them being a part of the whole sound. It is the presence in various proportions of these partials and, in particular, of the harmonics, which gives the sound its timbre or quality, making a violin sound so different from a penny whistle.

See also Vol. VIII: HARMONICS.

SOUTH AFRICA. The Union of South Africa (usually called South Africa) is over 400,000 square miles in area—or about eight times the size of England. Its population is more than 12 millions, of whom over $2\frac{1}{2}$ millions are white. Its northern boundary, the Limpopo River, lies just within the tropics; its southernmost point, Cape Agulhas, lies 35 degrees south of the Equator. From Cape Town to the Beit Bridge

THE DRAKENSBERG MOUNTAINS IN THE TRANSVAAL
South African Railways

over the Limpopo River is over 1,000 miles (*see* Map, p. 5[illegible]

An outstanding feature of South Africa is that it has a fairly narrow coastal plain, up to about 150 miles wide, above which the land rises sharply by a series of steep terraces to a great inland plateau edged by a rim of mountains. The whole is not unlike a huge wedding cake built in tiers. Most of the country is more than 4,000 feet above sea-level, and so, in spite of the fact that it is fairly near the Equator, the whole of the inland plateau, or High Veld, has severe frosts in winter. The rim of mountains (of which the Drakensberg or Dragon Mountains—11,000 feet—are the highest and most important) makes it difficult for the rain-bearing winds to reach the plateau, and it has, on the whole, a low rainfall. The steep sudden drop to the sea prevents the rivers being suitable for navigation, for they are either rushing torrents or half-dried beds.

One small section of the country ,the Western Province, with Cape Town [illegible] gets its rain in winter, like southern France and Italy. Like them, it grows grapes [illegible] wheat, and produces [illegible] pears, and apricots, many of [illegible] especially to Britain. The rest of [illegible] gets its rain almost entirely in [illegible] dry and usually cold winters. [illegible] Bloemfontein, the capital of the [illegible] State, gets almost no winter rain, but [illegible] frost throughout May, June, and July. [illegible] greatest in the east. Natal and [illegible] about 45 inches a year—and l[illegible] where at the mouth of the Ora[illegible] is only about 5 inches.

The variation in climate leads [illegible] variety of products. In the warm [illegible] north of Durban there are sugar [illegible] large that after supplying the [illegible] there is a surplus for export. Trop[illegible] as bananas, pine-apples, and paw-paws are also grown. The South Africans are a [illegible] people, and fruit is very plentiful [illegible] The frost-free northern and eastern [illegible] grow similar crops, and also tom[illegible] and other vegetables. These are distributed throughout the Union during the period [illegible] elsewhere. This area is called the Low Veld or the Bushveld. A large part of it, [illegible] National Park, is a game reserve, [illegible] snade on a grand scale, covering a[illegible] square miles—the area of Wales. There [illegible] numbers of many types of buck, zebra, [illegible] kudu, eland, as well as lions and jackals. No shooting of game is allowed. Rest camps are provided, and in June and July tho[illegible] visitors from the High Veld go to the reserve to see the animals in their wild state and to enjoy the warmer weather there.

The High Veld is very like the prairies of Canada. There are rolling grasslands where cattle ranching is popular and where wide areas are planted with maize (called mealies in South Africa). The average size of a farm here is about 1,000 acres.

Farther west, past Bloemfontein and Kimberley, the rainfall decreases, and grass is replaced by a small scrubby bush, about 6 inches high, called the karoo bush. The greater part of the Cape Colony has this type of vegetation. There are very few trees, except in the river-beds; and the farms, now about 10,000 acres in size, are mainly devoted to sheep farming. Still farther

TYPICAL VELD COUNTRY OF SOUTH AFRICA (NORTHERN TRANSVAAL)
South African Railways

[illegible] direction of the mouth of the Orange R[illegible] country gradually becomes more d[illegible] vegetation almost disappearing.

The rainfall of the High Veld comes in severe storms, during which 7 inches of rain may fall in a few hours, with long periods of drought between. The need for conserving water is therefore great, and several big irrigation dams have been built on the rivers—the Vaal dam on the Vaal River near Vereeniging being the biggest. Almost every farm has its own small earth dam; and a great deal of underground water is pumped up by metal windmills.

The High Veld is very rich in minerals. JOHANNESBURG (q.v.) grew from the wealth of the gold-mines, and diamonds have made Kimberley. There is plenty of coal in the Transvaal and Natal, and iron in the Transvaal. The area from Vereeniging to Pretoria is now highly industrialized, since gold and coal are found there and steel products are manufactured. The development of industry has been somewhat hampered by the lack of water transport; but there is a well-developed State-owned railway system, linking the interior to five great ports—Cape Town, Port Elizabeth, East London, and Durban in the Union of South Africa, and Lourenço Marques in Portuguese East Africa.

The Union of South Africa has two official languages—English and Afrikaans—the latter derived from, and rather like, Dutch. Parliament meets at Cape Town; the government offices are at Pretoria, nearly 1,000 miles away; and the Appeal Court sits at Bloemfontein, more or less in the centre of the country. This splitting up of the functions of a capital comes from the time when there were four separate states or colonies—the Cape Colony, Natal, the Orange Free State, and the Transvaal. Although these are united into the Union of South Africa, there is still a fairly strong provincial loyalty.

Since 1919, the former German colony of South-West Africa has been governed by the Union of South Africa as a mandated territory. The southern part of this huge area is largely desert; but in the north there are grasslands and cattle farming. The European population, partly German and partly South African, is very small, and the only town of note is Windhoek, the capital.

Gold is by far the biggest export of South Africa. The prosperity of the country depends

on it to a large extent. It is found mostly on the Witwatersrand (Ridge of White Waters), though gold-mining is now being started near Odendaalsrust in the northern Orange Free State. Many manufacturing industries have been started in the last thirty years, especially since 1940. Wool, most of which is exported, is the biggest agricultural product, then come mealies, and fruit of all kind. Sugar (in Natal), wheat (mainly near Cape Town), and dairy products are next in importance.

See also Vol. I: SOUTH AFRICANS.

SOUTH AMERICA. **1.** The continent of South America is a triangular-shaped land mass, a little smaller than the continent of North America, to which it is joined by the narrow Panama isthmus. The cutting of the PANAMA CANAL (q.v. Vol. IV) across this isthmus in 1911 made South America a continental island, the greater part of which lies in the southern hemisphere. The population is approximately 111 millions, of whom about half are in Brazil, a country larger than the United States of America.

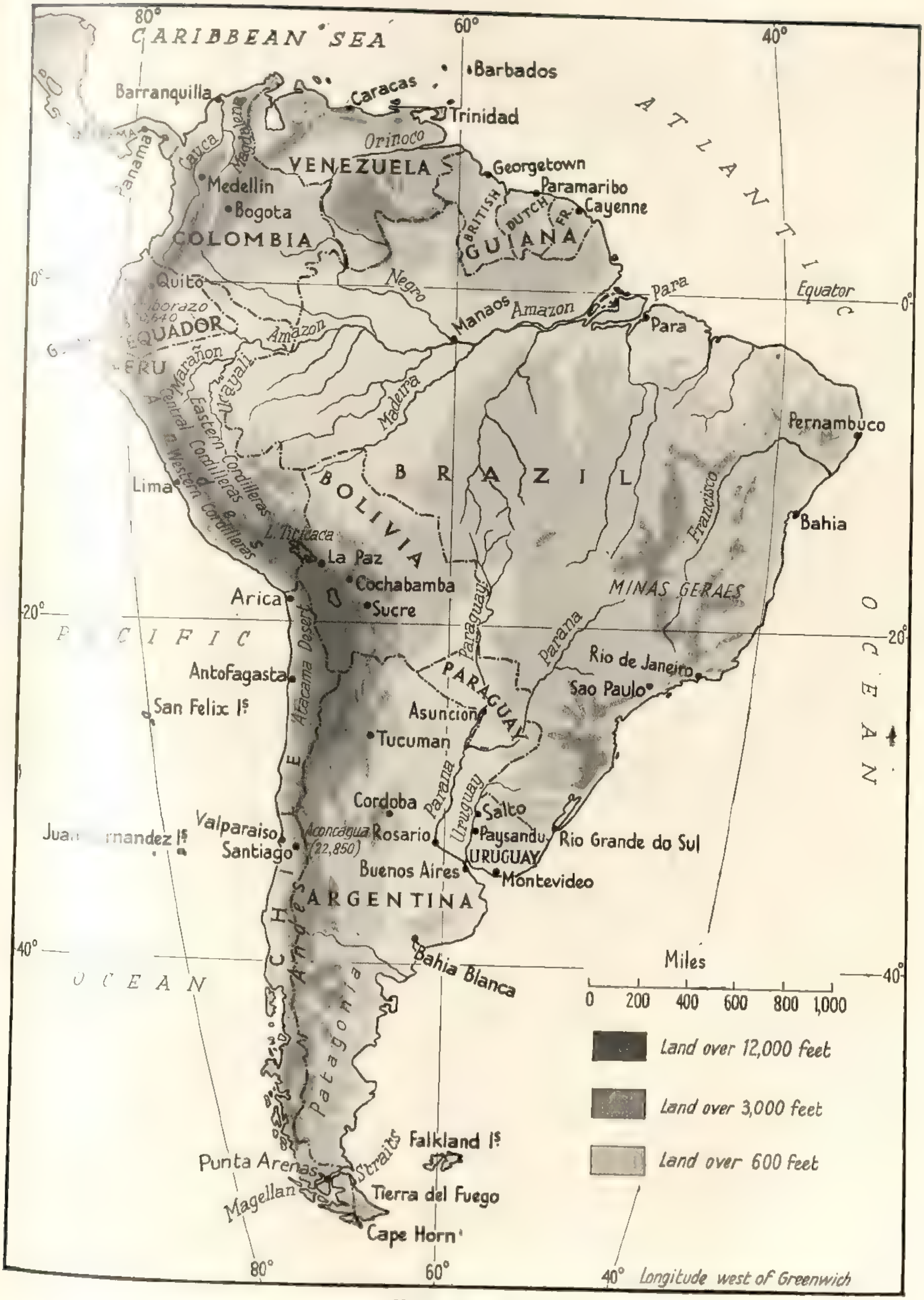
South America was first explored from Europe by the Spaniards and Portuguese, after the discovery of the WEST INDIES (q.v.) in 1492 by Columbus. In 1494 the Pope decreed that the eastern part of the New World should be Portuguese, and the western part Spanish. Working south-westwards from the Indies, the Spaniards explored first Peru and then Argentina and Chile. Brazil was discovered by the Portuguese in 1500. The Spaniards and Portuguese found the continent peopled by tribes of Indians (*see* AMERICAN INDIANS, CENTRAL AND SOUTH, Vol. I). In Peru, the INCAS (q.v. Vol. I) had developed a high state of civilization, which the Spaniards destroyed in order to establish Spanish rule and Christianity. Mineral wealth —the gold and diamonds of Brazil, the silver and copper of Peru, and the tin and silver of Bolivia—drew many explorers, and the continent was ransacked for its riches, the native peoples being forced to work for their conquerors.

Many Spanish and Portuguese colonists settled in South America and farmed, with the help of Indian labour. At the beginning of the 19th century the colonies, in a series of wars, threw off the rigid control of the Spanish and Portuguese, and set up independent republics. To-day there are ten Republics—BRAZIL, VENEZUELA, COLOMBIA, ECUADOR, PERU, BOLIVIA, CHILE, ARGENTINA, URUGUAY, AND PARAGUAY—and three colonies—the British, French, and Dutch GUIANAS (qq.v.). The physical character of these countries and the way of life of the people in them vary greatly, as is to be expected in so vast a continent. The peoples of all these republics are described in separate articles in Vol. I.

The structure of South America resembles in some ways that of North America. A high and continuous mountain belt borders the west coasts of both, and both have mountains and plateaux in the east. The central lowland of South America, however, is not continuous like that of North America, but is divided into three. The continent is most easily described in three main regions—the Andes, the Lowlands, and the Brazilian Plateau.

2. THE ANDES. The high parallel ranges of the Andes run from north to south, separated by deep valleys and inter-mountain plateaux. In some places there are three great chains, in others only two. The mountain belt is narrow from east to west, compared with the ROCKIES (q.v.) of North America; but at its widest, in Peru and Bolivia, it extends for some 500 miles. Very many ridges and peaks are over 15,000 feet high. Aconcagua, the highest peak, rises to 22,850 feet above sea-level, and like most of the other high peaks, is covered by perpetual snow. Most of the peaks are volcanoes, some being still active. From Ecuador to northern Chile there are high plateaux between the ranges, very hot and dry in summer and cold in winter. Winds blow mostly off the land, and therefore there is little or no rain: what vegetation exists, is rough grass or drought-resisting scrub. In northern Chile, the plateaux and the seaward slopes are known as the Atacama Desert—an area rich in nitrates and other minerals. This region is very sparsely peopled by Indians, who irrigate small patches of land on which they grow poor crops. In some places in the Peruvian Andes there are settlements of Indians at very high altitudes.

The northern and southern ends of the Andes have the most favourable climate, and so are most productive. The northern ranges lie across the Equator, and have an equatorial climate, with heavy rainfall, particularly on the west coast. The valleys and the lower mountain slopes are covered with tropical forests. The original thick jungle has been cleared in some



SOUTH AMERICA

places and planted with such crops as cocoa and bananas. Higher up and on the upland plateaux and basins there is grassland, some of which is suitable for grazing and some for growing coffee.

The southern Andes get a good rainfall from the west, and the mountains are well forested with timber trees. Central Chile has the densest population of the whole Andean region, most of it concentrated in the long narrow valley, running from VALPARAISO (q.v.) to Valdivia, behind the coastal ranges. With a Mediterranean climate and fertile soil, it is an important agricultural area, growing some grains, but especially vines and citrus fruits.

3. THE LOWLANDS. This part of South America falls into three natural regions, each watered by one of the three great rivers, the Orinoco, the Amazon, and the Plate, with their tributaries, and separated from each other by high land. The western Orinoco basin, or 'llanos' is in Colombia and Venezuela. It is hot, moderately wet prairie land of grass and scattered trees, famous cattle country, with large ranches and a very scanty population. The eastern and lower Orinoco basin is swampy, thick forest, very like the lower Amazon in its dense vegetation.

The Amazon basin is the northern third of Brazil, and extends westward into Peru, Ecuador, and Bolivia, right to the Andes. It is ringed with highlands, except on the seaward side, where the AMAZON (q.v.) enters the Atlantic as a vast muddy stream almost a hundred miles wide. The climate is very hot and unhealthy, with heavy equatorial rainfall. There is thick jungle and extensive swamp, through which the tributaries of the Amazon are the only highways. The Amazon basin is peopled mainly by primitive tribes, concentrated along the river-banks and dependent on a primitive agriculture. The forests contain great wealth in timber, but the timber trees are so scattered and the heat so excessive that exploitation is difficult.

The third lowland is the 'pampas' or the valleys of the Paraguay, Parana, and Uruguay Rivers, all of which flow into the broad Plate estuary. These lowlands stretch across parts of Argentina, Paraguay, Uruguay, and the southern end of Brazil. The flat or undulating plains have fertile, well-drained soil, and are covered with long grasses and trees, or, where rainfall is smaller, with a shorter prairie grass. Rainfall in the south-east is good and well distributed; but inland, towards the Andes, it gradually decreases, and the southern plateau of Patagonia in Argentina is very dry. Summers are very hot in the northern half of Argentina and in Paraguay. These plains were not developed for settlement and agriculture until after 1810 and the creation of the South American republics, and settlement is still extending farther west and north. Railways were built from the 1870's onwards, and to-day there is a very close network. The land is divided into huge estates or ranches, and cattle and sheep-rearing are the most important occupations, with sheep-rearing more important in the drier areas. Round the Plate estuary, wheat and maize are grown in vast quantity. Farther north, up the Parana valley, there are sugar plantations. Both agriculture and cattle-breeding are organized scientifically, so that a great export trade has been built up. BUENOS AIRES (q.v.) is the centre of the meat-packing industry for export, and hides and wool are also exported. Argentina possesses more large towns than any other South American state, and industrial development continues.

4. THE BRAZILIAN PLATEAU. The third main region of South America covers the southern two-thirds of Brazil and western Bolivia. It is a plateau block of old hard rocks, over 2,000 feet high on its eastern edge and becoming gradually lower inland. It is triangular-shaped, broadest along the Atlantic coast, with its apex joining the Andes in Bolivia. It forms a water-divide between rivers draining east to the Atlantic, north to the Amazon, and south to the Paraguay and Parana Rivers. The plateau has everywhere a hot climate, with a heavy rainfall, though winter is relatively dry. Grassland with mixed woodland is the general vegetation, with thick jungle in the hot, swampy valleys. Cattle-rearing has been developed in the southern parts of the plateau where these adjoin the pampas. Coffee, one of Brazil's most important crops, is grown for export on the eastern slopes of the plateau between São Paulo and Victoria. North of this there are rich iron deposits awaiting exploitation. Settlement, especially in coffee plantations, is still expanding in Brazil, as elsewhere in South America, and is creeping westwards from the São Paulo region, and southwards towards the pampas. The region surrounding the great cosmopolitan city of RIO

DE JANEIRO (q.v.) is one of the most densely populated in the whole continent.

SOUTHERN CROSS, *see* CONSTELLATIONS.

SOUTH POLE, *see* POLAR REGIONS.

SOUTH SEA ISLANDS, *see* PACIFIC ISLANDS.

SPACE. Until the present century, the idea of space gave scientists little difficulty beyond that of imagining anything stretching on for ever. It was regarded as quite different and distinct from time. EINSTEIN (q.v. Vol. V) took the view in his theory of RELATIVITY (q.v.), however, that space and time are closely connected and dependent on each other, TIME (q.v.) being no more than the fourth dimension or measurement of the complete 'space-time continuum', of which the other three are the usual dimensions, length, breadth, and depth. His theory also stated that space is curved.

It is difficult to imagine curved space; but it may help if we imagine how it would appear to people living in a two-dimensional world if their space was curved. Two-dimensional people would be like pictures, and their space would be like a flat sheet of paper, having only length and breadth. They would be unable to think of depth (just as we are unable to think of a fourth dimension beyond depth). Suppose, now, that we curved their space, so that it became the shape of part of a globe, like Fig. 1*a*, or else the shape of a saddle, like Fig. 1*b*. They would deny

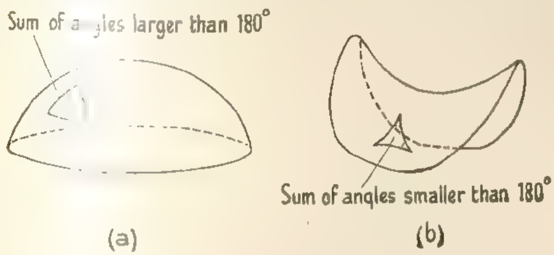


FIG. 1

that it was curved, because they would have no conception of 'up and down'—or depth. But what would happen if one of their two-dimensional mathematicians tried to check by measuring one or two simple geometrical theorems on its surface—as that 'the sum of the angles of a triangle is equal to two right-angles' for instance, or 'the circumference of a circle is $\frac{22}{7}$ times the diameter'? If the space was curved like Fig. 1*a*, he would discover to his astonishment that the sum of the angles was more than it should be and the diameter of his circle was larger than it should be; if it was curved like Fig. 1*b* the errors would be reversed. This experiment would prove to him that the space in which he lived was curved—even though he could not picture it in his mind. In the same way Einstein said as part of his theory of relativity that the three-dimensional space in which we live is curved, and he proved this by examining the properties of GRAVITATION (q.v.). Hitherto, gravitation (or the tendency of a body to be attracted by other bodies) had been accepted as something that 'just happened'. Einstein proved that all the phenomena of gravitation could be reproduced exactly by acceleration—that is, by continually increasing (or decreasing) the speed of a body.

Let us imagine ourselves watching a scientist making experiments in a small laboratory he has fitted up inside a rocket-ship. He begins by rising so far above the Earth that all its gravitational pull is lost. Then hovering motionless in space, he lets go an apple he has been holding in one hand. As there is no force of gravity to make it fall, the apple remains suspended in mid-air. The scientist then gives his ship an upward acceleration equal to that of a falling body near the Earth's surface. Immediately, the apple falls to the floor in the normal way, and he feels the pressure of his own weight on the soles of his feet again. In fact, so far as he can tell, all the usual happenings of gravitation are restored. As observers outside the ship, however, we notice a very peculiar thing. A magic lantern is projecting a ray of light across the scientist's laboratory on to a screen. Owing to the enormous acceleration of the ship through space, its speed is becoming comparable with that of LIGHT itself (q.v.), so that during the time the light takes to travel from the lantern to the screen the whole laboratory has moved a little—and so we see the rays as slightly curved (though to the scientist, himself being accelerated, it looks quite straight). We notice another curious thing. The magic lantern throws a circle of light on the screen; but when we measure it, we find that the diameter of this circle will go more than $\frac{22}{7}$ times into its circumference. The scientist is quite satisfied that the circle is accurate—as, indeed, it is in relation to him; but to check matters further, he slips into the lantern a mask

[illegible] three spots of light on the screen. While he measures the sum of the angles of the triangle thus formed, and finds that it is equal to two right-angles, we take the opportunity of [illegible] and we find it adds up to more. There can be no doubt about it: our geometry has gone wrong, and so we are obliged to conclude that the space inside the [illegible] has, in some way, become curved.

At first sight it [illegible] bending a ray of light [illegible] than we should expect gravitation to do. But Einstein maintained that if only sufficiently accurate measurements were taken, the effects of gravitation would be found to be exactly like those of acceleration—including even the bending of a ray of light. One of the most convincing proofs of the truth of his theory of relativity was given when he calculated that the light from a star would be found to be bent through a very small angle as it passed close to the huge gravitational mass of the Sun. This could only be checked during a total eclipse, when the cutting off of the Sun's light would allow the light from the star to be observed with accuracy. The whole scientific world waited eagerly for the day of the eclipse, 29 May 1919—and the calculation was proved accurate. Since then relativity has helped astronomers to solve many puzzling problems. Einstein's proof that space is curved may be put shortly as follows: the effects of gravitation are exactly the same as those of acceleration. With acceleration, space is always curved, as proved by the fact that the ordinary geometry of Euclid goes wrong. With gravitation, then, space must always be curved, too. In that case, we should regard gravitation simply as a physical indication that space is curved—and the stronger the gravitational force, the greater the curvature of space.

In order to make his calculations, Einstein made use of a new kind of four-dimensional geometry. This appears very strange indeed to those used to thinking of geometry only in two or three dimensions. As the fourth dimension is that of time, curious results follow. A point, which in ordinary geometry 'has position but no magnitude', must be regarded as having many positions; and so it is no longer true to say, as in Euclid's geometry, that 'through a point it is possible to draw only one straight line parallel to a given straight line'. Again, in this new geometry, owing to the curvature of space, it is possible for parallel [illegible] until they do meet. Even a straight line can no longer be defined [illegible] the shortest distance between two points [illegible] of light bending and [illegible] owing to the [illegible] RELATIVITY, the word [illegible] meaning and should [illegible] 'curved'. It is interesting to note that [illegible] space-time geometry, the [illegible] by the Earth and planets [illegible] followed not because of gravitation [illegible] but because they are the [illegible] available through the curves of space. The question of the actual shape of space in our universe is one to which [illegible] geometry gives several possible answers. It may be closed on itself—and therefore [illegible], but the view most favoured is that it is [illegible] as can be described, [illegible] and, furthermore, that it is [illegible] expanding.

For most of their calculations, [illegible] find the older physics and geometry [illegible] ciently accurate; perhaps the greatest importance of the new ideas at the present [illegible] lies in the revolution of thought which [illegible] accomplished.

See also RELATIVITY, TIME.

SPAIN. Spain and Portugal together [illegible] the Iberian Peninsula, which juts out [illegible] at the extreme south-west of Europe [illegible] Map, p. 160). Hundreds of thousands of [illegible] ago, Spain and Africa were joined together [illegible] one great mass of land, but now they are separated by a narrow stretch of water, only 10 miles wide, which connects the Mediterranean and the Atlantic and is guarded by the British naval base at Gibraltar.

Spain is sometimes called the 'Unknown Country of Europe'. The PYRENEES mountains (q.v.), rising in some places to over 11,000 feet, have acted as a natural barrier to invaders from the rest of Europe. Any other approach must be by sea—across the Bay of Biscay, from the Atlantic, or the Mediterranean. Spain is over twice the size of Britain, but has a little less than half the population—about twenty-two millions. The country is mountainous, much of it very barren, and almost everywhere shortage of water is a problem. In the small towns and villages the water-vendor makes his way down

TOLEDO, IN THE SPANISH MESETA
The Alcazar stands high above the Gorge of the Tajuna *P. Hart*

the [illegible]ts with pails of water slung on a long [illegible] over his shoulders. The five main rivers are turbulent and full of whirlpools. Except for the Guadalquivir they are useless for navigation and poor for irrigation purposes. In the north-east, however, the Ebro and its tributaries are used for generating electric power which [illegible] the industrial city of Barcelona.

The country has many different kinds of land and climate, but can be divided into three main natural regions. The 'Meseta' is the high plateau of land which occupies all the centre of Spain. It is surrounded on the north by the Pyrenees and Cantabrian mountains, and on the south by the Sierra Morena and Sierra Nevada. It is crossed continuously by the characteristic saw-toothed jagged ranges of mountains called Sierra (Spanish for 'saw'). The Meseta has a blazing hot summer and bitterly cold winter, with hardly any rainfall. The country is barren and treeless, in some places almost desert. Life on the Meseta is hard. In many parts the soil is so poor that the peasants carry up earth in baskets on their backs from richer areas. Water is carried miles in carts or pumped from deep wells by donkeys. This is the land of the merino sheep and of goats, and the shepherds often drive their flocks 200 miles in spring in search of pasture and back again in autumn. The population is scanty and there are few large towns, the principal one being MADRID (q.v.), which is the natural meeting-place of roads and railways, and is now the capital of Spain. In the southern regions of the Meseta is to be found much of the mineral wealth of Spain—silver, lead, copper, and some of the richest quicksilver mines in the world.

The north and north-west coastal region is much richer and more prosperous. It is well watered by rain-bearing westerly winds, and has cool winters and warm summers. It has fine forests of oak, beech, and Spanish chestnut, in which the wild boar is still hunted. The coast is rugged with many inlets, which make excellent fishing harbours for the flourishing sardine industry. Inland there is good wheat, dairy-, sheep-, and fruit-farming. The region is rich in iron-ore, and coal is mined near Oviedo.

The third region, southern Spain and the Mediterranean coast-land, is very hot. Even bananas and dates will ripen, and, in the hot steamy valley of the Guadalquivir, rice is successfully grown. It is only by irrigation, however,

that the peasants are able to cultivate their [illegible] almonds, maize, cotton, and sugar. The coastal plains are famous for their terraced vineyards, and Jerez [illegible] sherry) and Malaga are centres of the wine industry. Olive oil, used by the Spaniards as a substitute for butter, and [illegible] oranges for marmalade, are exported from Seville.

See also Vol. I: Spaniards.

SPECIFIC GRAVITY, *see* Density.

SPECTRUM, *see* Colour.

SPICE ISLANDS, *see* Indian Ocean Islands.

SPITSBERGEN (Svalbard) is an Arctic archipelago of several large and many small islands, all together about three times the size of Wales, lying about 300 miles north of Norway (*see* Map, p. 346). With the small Bear Island halfway from Norway, Spitsbergen is now the Norwegian territory of Svalbard. In the west the land is mountainous with many glaciers; in the interior there is much ice-free land; but in the east most of the surface is ice-covered. The climate is cold and stormy, but summer days are occasionally as warm as in England. There are many bright-coloured flowers on the low land which is free from snow all summer. Reindeer, foxes, and, in winter, polar [illegible] used to be far more numerous than now, [illegible] heavy toll having been taken of them during the last century by fur-trappers (*see* Fur H[illegible], and Fur Farming, Vol. VI). Musk-oxen [illegible] lately been introduced. Sea-birds in great numbers nest in the islands in summer.

The islands were discovered by the [illegible] at the end of the 16th century, and have [illegible] been thoroughly explored by whalers, sea[illegible], and scientific explorers. It was from Spitsbergen that R. E. Byrd flew to the Pole and back, and Amundsen flew over the Pole to Alaska [illegible] 1926. The islands belonged to no state until 1925, when Norway's sovereignty there began. They are valuable possessions because of the rich coal deposits they contain. The [illegible] are worked by Norwegians and Russians [illegible] the year; but coal is exported only i[illegible]

A GLACIER REACHES THE SEA IN MAGDALENA BAY, SPITSBERGEN
Seton Gordon

During the Second World War the mines were put out of action to prevent their falling into German hands; but they have now been re-established.

See also Polar Regions; Polar Regions (Exploration).

SPRINGS, *see* Wells and Springs; Geysers (hot springs).

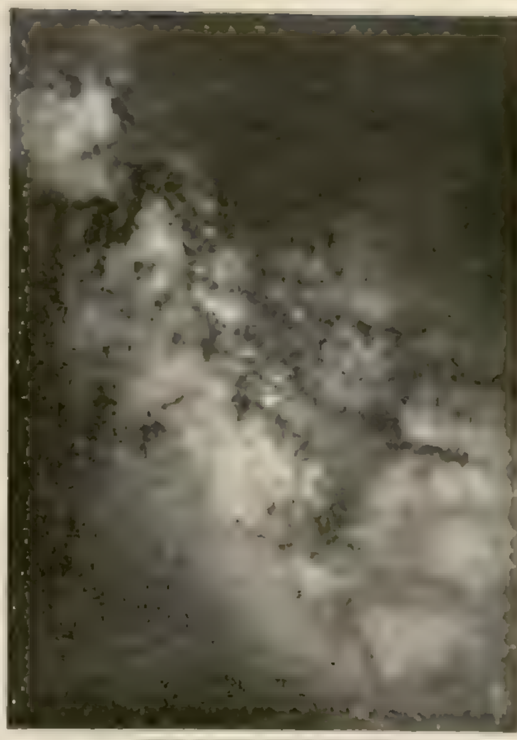
STA[illegible]MITES AND STALACTITES, *see* [illegible]

STARS. Stars are at such high temperatures that they give off their own light, whereas PLAN[illegible] (q.v.) and satellites can be seen only [illegible] light reflected from them. All stars [illegible] q.v.) are at such immense [illegible] the EARTH (q.v.) that they are [illegible] points of light. It is because we see them [illegible]ch minute points of light that they [illegible]kle when looked at through the [illegible] of our atmosphere. The planets, which [illegible] much closer and are seen as disks, do not tw[illegible] so noticeably. Stars are classified by means [illegible] the spectroscope, which splits up their light, b[illegible] prism, into bands of different colours crossed by dark and bright lines (*see* COLOUR). By stu[illegible]ng these, astronomers can find out a great deal about any star's temperature, composition, motion, and so on. Classification is mainly [illegible] colour—the 'blue' type such as Sirius, the 'ye[illegible]' type such as the Sun, and the 'red' type s[illegible] as Betelgeuse, for example.

Whe[illegible] astronomers speak of 'giants' and 'dwarfs', [illegible]ey are referring to the sizes of stars; but [illegible] use the word 'magnitude' (or 'app[illegible] magnitude'), they are referring to their a[illegible]rent brightness. As for sizes, many stars a[illegible] thousands of times as large as the Sun: Betelge[illegible] for instance, could contain in its diamete[illegible] the whole circuit of the Earth round the Su[illegible] while others may be millions of times smaller. Surface temperatures range from about [illegible]° C. to 23,000° C.—and when we think that the hottest furnace of any useful size can only be made to reach about 4,000°, it will be realized how almost unbelievably hot some stars are, even on the outside. Inside, their temperatures reach heights quite beyond our comprehension: the centre of the Sun, for instance, has been calculated to be at 20 million degrees. At such colossal temperatures, matter itself exists in states never found on the Earth. Its density may be so great that the most powerful crane would be unable to lift even one bucketful.

Only about 3,000 stars are visible at any one time to the naked eye; but it is estimated that some 1,500 million could be picked out with the aid of instruments, and of these about a quarter of a million have already been catalogued.

Very many stars which appear as single are found by instruments to be 'double'—i.e. a pair of stars close together, revolving round their common centre of gravity. Sometimes the pair can be seen separately; but sometimes the existence of a 'twin star' is deduced from fluctuations in the light given out—as when a dim star is revolving round a bright one. Sometimes such fluctuations are due to real changes of brightness. A star whose light is not constant is called a 'variable'. What causes these latter fluctuations is not known for certain; but the phenomenon can at times be put to use in calculating a star's distance. Occasionally, a star will suddenly show a very great increase of brilliance and then fade to a steady brightness greater than it had before. Such stars are called 'novae', and again, the nature of the event is not understood, and cannot be predicted. If our own Sun were ever to do this, it seems certain that all life on Earth would perish.



STAR-CLOUDS IN SAGITTARIUS

Mt. Wilson Observatory

See also CONSTELLATIONS; UNIVERSE; ASTRONOMY, MEASUREMENTS OF.

STEPPE, *see* UKRAINE; R.S.F.S.R., Section 5.

STOCKHOLM: IN THE FOREGROUND IS THE ROYAL PALACE, WITH THE PARLIAMENT BUILDING BEYOND. *Mor*

STOCKHOLM. With some reason Stockholm, the capital of Sweden, has been called the Venice of the North. It is crossed from east to west by a long channel, part of which is Lake Malar; some of it is built on islands; and much of its traffic is by water—though its ferry-boats bear little resemblance to Venetian gondolas.

The main town lies north of the Channel, while to the south of it is the district of Södermalm—chiefly high rocky hills and cliffed terraces. There are several islands in the Channel. On the Island of Staden inom Broarna, usually known as Staden, is the oldest part of Stockholm. Here are the Royal Palace, with its famous collection of Gobelin tapestries, Stor Kyrkan (the Great Church), and, in the western part or Riddarholmen, the very lovely 17th-century palace built for Queen Christina, and the Riddarholmskyrka where many of the kings of Sweden are buried. The new Parliament House stands on a small island between Staden and the main town. Norrbro, the bridge connecting Staden with the main town by way of this island, leads into the principal square of the modern city, Gustav-Adolf-Torg. This is the heart of Stockholm. From it stretch the main shopping streets. One of the most famous streets, the Strondvagen, does not lead directly from the square, however, but is approached from it eastward. It is a broad promenade with quays on one side and huge mansions and expensive shops on the other.

Stockholm is renowned for its modern architecture. The magnificent Town Hall, completed in 1923, is known all over the world, and there are many fine commercial buildings as well as schools and government offices.

North and south traffic was for long a great problem—the only land route being by Staden Island and the broad Slussen crossing at its southern end. A solution has been found by the

building of two big bridges across Lake Malar and by a clover-leaf crossing with two streets at different levels and three spiral ramps.

See also SWEDEN.

STONE, *see* ROCKS; MINERALS.

STONES, PRECIOUS, *see* PRECIOUS STONES.

STRAITS SETTLEMENTS, *see* MALAYA.

STRATOSPHERE, *see* ATMOSPHERE.

SUDAN. The Sudan stretches across North Africa from the Atlantic in the west to the RED SEA and ABYSSINIA in the east (*see* Map, p. 5). North of it lies the SAHARA and EGYPT; to the south it is bounded by the GUINEA LANDS, the BELGIAN CONGO, and EAST AFRICA (qq.v.). It includes French Sudan, Niger Colony, and Anglo-Egyptian Sudan. The people of the Sudan are ARAB mixed with Negro (q.v. Vol. I)—Sudan means 'Land of the Blacks'. Many are nomadic, and the main native villages are markets and trading places rather than settlements.

In the north, large areas of the Sudan are virtually DESERTS (q.v.)—vast, brown, parched, stony plains, crossed by river-beds that are dry for the greater part of the year. Thorn scrub and mimosa are the predominant vegetation. Luckily there are wells and water-holes, so that in spite of the low rainfall and the very poor pasture, small herds of sheep and goats can be kept. There is a limited amount of cultivation, chiefly of *durra*, a type of millet which is pounded in a mortar and made into a kind of porridge.

Southwards, savannah of tall grasses up to 6 feet in height takes the place of desert, and in the south there is cultivation of millet. Nomadic tribes rear camels, goats, and sheep in the north. The country is in the main very flat; though small isolated hills, called *Jebels*, rise abruptly, and along the Red Sea coast there is a narrow range of mountains. The climate is difficult—tropical heat by day contrasts uncomfortably with bitterly cold nights. The scanty rain falls in summer. Some areas have practically no rain, while in others long periods of drought are broken by downpours which destroy crops and cause floods.

The most fertile part of the Sudan is that area of the Anglo-Egyptian Sudan which is watered by the Nile, and is about five million acres in extent. The NILE (q.v.) crosses the region from south to north, and the land bordering it differs from the rest of the country. In the south there are the great swamps of the 'Sudd', with its

THE DESERT NEAR OMDURMAN, ANGLO-EGYPTIAN SUDAN
Royal Geographical Society

islands of floating vegetation and stretches of papyrus grass as much as 15 feet high. Below the town of Sennar on the Blue Nile, a great barrage, the Sennar Dam, has been built, and a district called the Gezira has been irrigated so that it can grow crops, such as millet, clover, cotton, and sugar. Along the banks of the river, the land in many parts is still irrigated by water raised by primitive water-wheels.

Perhaps the most interesting of the peoples of the Anglo-Egyptian Sudan are those which live in the Sudd region, particularly the Shilluk, the Dinka, and the Nuer (q.v. Vol. I). These swamp dwellers show a resemblance to swamp birds. They are very tall—6 feet 7 inches, or even taller—and, like swamp birds, they sometimes stand for hours on one leg. Their long-leggedness enables them to wade through swamp regions where shorter men would be unable to move. They protect themselves from the myriads of mosquitoes which rise from the swamp by wetting their bodies and then covering them with wood ash, which gives them a most ghost-like appearance.

Khartoum, the capital and government centre of Anglo-Egyptian Sudan, is a port on the Nile and a rail centre. It is a well-planned town of wide streets, handsome buildings, and broad open spaces, planted with trees and shrubs. Omdurman, the former capital, has a very much larger population. It is a Sudanese town with sandy streets and narrow, twisting lanes bounded by high walls. The Red Sea port, Port Sudan, is equipped with mechanical facilities for handling coal and cotton, and much money has been spent in making its harbour safe.

Bammako is the capital of French Sudan. It is connected by rail to the port of Dakar in Senegal. Timbuktu, in the desert area of the north, is an important caravan centre. The capital of Niger Colony is Niamey on the River Niger.

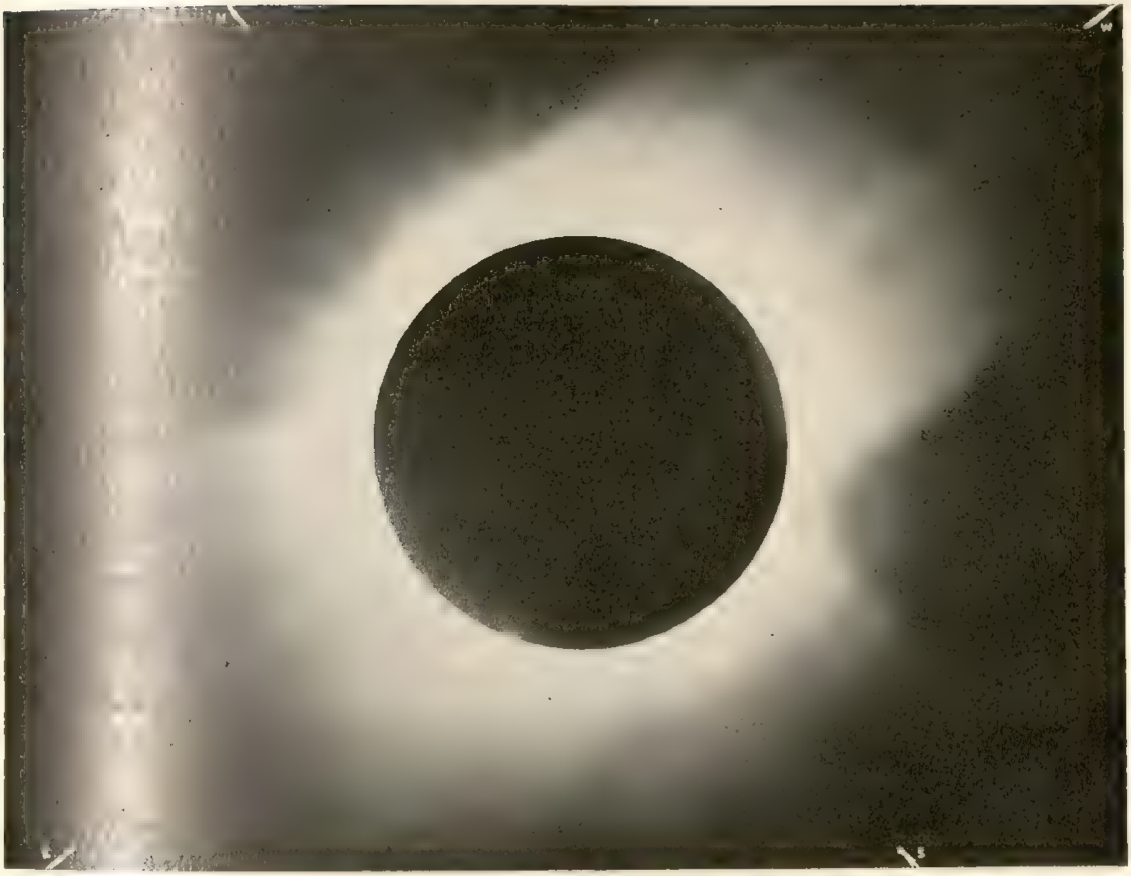
SUEZ, *see* Egypt; *see also* Vol. IV: Suez Canal.

SUMATRA, *see* East Indies.

SUN. The Sun is just one of the mi[llion]s of stars in the universe, not particularly [large] as stars go, nor particularly small. But to [hum]an beings it is, quite literally, of vital im[porta]nce, because without the light and heat it [gives] us, our Earth would be a frozen, lifeless [globe]. So far as we can tell up to the present, [no ot]her star has a developed 'solar system' of pl[anets] like ours revolving round it; but in sayi[ng this] we must remember that even the neares[t star] lies at such an immense distance away tha[t no ex]isting telescope would be likely to [reveal] the presence of satellites.

With a diameter of 865,000 miles, th[e Su]n is more than a million times larger in vol[ume t]han the Earth. It has magnetic properti[es like] the Earth, and it rotates on its axis from ea[st to w]est. But it does not rotate like a solid body[: the s]olar equator turns once in about twenty-f[ive an]d a half days; but the poles take some nine days

THE SUN, SHOWING SUN-SPOTS
Royal Observatory, Greenwich



THE SOLAR ECLIPSE IN 1919, SHOWING THE CORONA AND A PROMINENCE ON THE LOWER LEFT-HAND SIDE
Royal Observatory, Greenwich

longer. This rotation is shown by the movement of what are called 'sun-spots', which can be seen and photographed as they travel round its surface. The Chinese seem to have studied these spots with the naked eye as early as A.D. 200; but general interest in them was first aroused in Europe when GALILEO (q.v. Vol. V) observed them through his newly-invented telescope in 1610.

Sun-spots generally lie between latitudes of 35° N. and S. of the Sun's equator. As a rule they begin in pairs as circular whirlpools (of opposite magnetic polarity), starting at high latitudes and, in a later development, taking on twisted shapes as they drift towards the equator. After a time, which may be a few days or a few weeks, they break up and disappear. It has been found that there are periods of maximum and minimum sun-spot activity, the peak being reached about every eleven years. At such times it seems that the Sun's heat may be greater than usual—and this may cause more evaporation and ice-melting on Earth, so that on some parts of the Earth we get more rain. At these times, too, more frequent magnetic storms occur, causing sudden changes in the behaviour of a compass needle and freak radio effects; the AURORA BOREALIS (q.v.) is also more in evidence (*see* MAGNETISM *and* ELECTRICITY IN NATURE). A sun-spot is cooler than its surroundings, and is known to be a centre of a strong magnetic field; so perhaps electrically charged particles are shot out from it into the Earth's upper atmosphere, where they cause the disturbances mentioned. Apart from sun-spots, the general surface of the Sun shows a mottled pattern which quickly alters. At a total eclipse, huge prominences can be seen, which may possibly have some connexion with sun-spots.

By analysing its light through a spectroscope, astronomers have been able to find out a great deal about the composition of the Sun (*see*

Colour). It contains most of our own chemical elements, but a number of the heavier ones known on Earth seem to be absent, though it is possible that they have sunk into the Sun's interior (*see* Matter). It is interesting to note that helium was discovered as a 'new element' in the Sun some years before it was isolated on the Earth.

In spite of the heavy metals which it contains, the density of the Sun is only about one and a half times that of water. This suggests that the Sun is not solid but gaseous, though its inner layers must be under immense pressure owing to the pull of its own Gravitation (q.v.). Though the Sun is gaseous, it has a well-defined edge or surface called the 'photosphere'. Outside are layers of cooler but still glowing gases called the 'chromosphere'. Beyond this, licking sometimes 50,000 miles into space, are the great flames known as 'prominences'. And extending many thousands of miles beyond these is the 'corona', the pearly-white aureole which becomes visible round the Sun during a total Eclipse (q.v.). The light of this may be due to the reflection of the general sunlight from particles of molecular size. Its spectrum contains some unusual bright lines. As it is known that these cannot represent new elements, they may possibly be due to the atoms of known elements in abnormal states. The temperature of the Sun's surface is 6,000° C.; but its high-pressure interior may be at some 20 million degrees.

Each square centimetre of the Sun's surface has a brilliance of some 50,000 candle-power and emits energy at the rate of about 9 horse-power. The Earth collects no more than one part in 2,200 million of the total—and yet this amounts to about 5 million horse-power on every square mile of its surface. Attempts have been made to get useful mechanical work out of this energy—for instance, by focusing the heat with mirrors on to steam-boilers—but with no great success. So far, only plants are able to transform it usefully by the process known as Photosynthesis (q.v. Vol. II).

What is the source of the Sun's energy? Its own internal store of heat would not be enough to keep up its present output for more than a few thousand years; yet it seems, from geological evidence, that the Earth has had a steady supply of heat for very much longer. How has this been maintained? It was suggested that the impact of meteors hitting the Sun's surface might serve; but calculations soon showed that this could not supply nearly enough. Another suggestion was that the Sun was gradually shrinking in diameter by about 75 yards a year, and that the movement of matter towards its centre of gravity could liberate the necessary energy; but this theory again disagrees with the findings of geologists about the age of the Earth and the means by which such energy could appear as light remains unexplained. Then when radium was discovered, and found to emit energy continually, it was thought that here was the solution to the problem. However, it is now thought most unlikely that enough radium could be present in the Sun.

More recently Einstein has stated that matter can be converted into energy—a theory that has found practical proof in the atomic bombs. Here, then, may be the source of the Sun's energy. To keep up its present rate of emission this would mean that it is losing mass at the rate of about 4 million tons per second. This is not so alarming a figure as it sounds: it would be quite a negligible loss to the Sun. There may well be some process at work by which hydrogen, which is very abundant on the Sun, is being converted into helium, and this process would liberate heat energy much as in the case of the atomic bomb. But this takes us to the very limits of our present knowledge of atom splitting. It may be that further research will soon answer the question.

See also Astronomy, Modern; Astronomy, Measurements of; Calendar; Stars; Universe.

SWAMP, *see* Moorland and Marsh, Section 2.

SWEDEN. This is the eastern part of the long peninsula of Scandinavia (*see* Map, p. 160). The boundary with Norway runs for most of its length along the high mountains in the interior of the peninsula. North Sweden is mainly forest, while central and south Sweden is a land of farms, towns, and industry.

North Sweden stretches beyond the Arctic Circle and is the home of about 7,000 Lapps (q.v. Vol. I) still mainly nomads. With its high peaks, enormous glaciers, and mountain lakes, it is very beautiful country. The mountains drop in vast steps from the Norwegian frontier to a strip of plain along the shores of the Gulf of Bothnia. Many rivers flow from the mountains to the Gulf, and each of them opens out into a

A LAKESIDE VILLAGE IN CENTRAL SWEDEN
Swedish Travel Bureau

lake at the foot of the biggest of these steps; so there is a line of lakes, roughly parallel to the coast, at about the same height above sea-level. Some of the lakes have been drained, and the old beds make good agricultural land. Coniferous forest covers most of north Sweden except near the coast, where there is farmland. Here, too, are saw-mills to deal with the timber from the forest, much of which is made into pulp. The other industry of north Sweden is concentrated in two small areas, one north of the Arctic Circle and the other on the Dal River in the south. The latter has important deposits of iron-ore especially suited for very fine steel. In the north, near Kiruna, a very high grade iron-ore is mined from the hills, some of which contain ore right up to their summits. By great hydro-electric schemes power has been obtained for factories, railways, and mine machinery.

Central Sweden is lakeland. It is low, hummocky country of forest-covered ridges, swamps, moorland, meadows, farmland, and orchards. White wooden manor houses and small red-painted cottages are characteristic of the country-side. STOCKHOLM (q.v.) and Gothenburg, the two largest towns in Sweden, are built one at each end of it. Cheap communication has been developed over the whole area by connecting the lakes with canals.

Southern Sweden is quite different. In the centre is the rocky forested highland of Smaland. Round this lies the coastal lowland, which is very fertile, especially to the south, in the Skane peninsula—the richest farmland in Scandinavia. Wheat and sugar-beet are important crops.

The large island of Gottland in the Baltic Sea used to be a centre of medieval Swedish culture. The ruins of the city of Visby, destroyed by the Danes in 1361, are evidence of its former prosperity. Now the island is a popular summer tourist resort, because of its fine beaches.

Sweden exports iron and steel goods, and timber products such as wood-pulp, paper, furniture, and matches. She has to import textiles, coal, oil, and some grain.

See also Vol. I: SWEDES.

SWITZERLAND. The Helvetian Confederation, as the Swiss sometimes call their country, is one of the smallest and one of the most mountainous countries in Europe (*see* Map, p. 160). The ALPS (q.v.) and the Jura Mountains occupy nearly three-quarters of its 15,900 square miles, and yet over 12,000 square miles are productive in some way—either as forest, vineyard, or pasture.

The Alps are in the south. The Mont Blanc range in the south-west, is on the frontier separating Switzerland, Italy, and France. Equally famous are the Dents du Midi, seen best from the Lake of Geneva, the Jungfrau, towering over the town of Interlaken, and the tooth-like Matterhorn, too steep to hold snow on its highest slopes, where more climbers have been killed than on any other Swiss mountain. This is a region of huge snow-covered mountains and deep valleys, of long narrow lakes and rushing rivers, of glaciers and avalanches and dark forests, of small wooden farm-houses with roofs held down by large stones to keep them from blowing away in winter gales. There are huge hydro-electric stations, and high summer-meadows where pale-skinned cows graze, hock

THE LAKE OF ZUG IN THE CANTON OF ZUG, CENTRAL SWITZERLAND. *Swiss Federal Railways*

deep in brilliant flowers, with big bells on leather collars clanging at their necks.

Along the north-west frontier, between the Alps and the Jura Mountains, there is a high hilly plateau of fertile dairy-farms and intensive industry based on the abundant hydro-electric power available. Cheese, condensed milk, chocolate, silk, cotton, watches, and machinery are manufactured in factories scattered over the country-side. Zürich, the largest town, has very varied industries, especially that of silk-weaving, and is a commercial and intellectual centre. GENEVA, and BERN (qq.v.), the Federal capital of the twenty-two cantons, are next in [illegible]

The Jura Mountains are a region of parallel ridges and valleys, important for dairying and forestry, with vineyards on the south-east slopes overlooking the plateau. Basel (Basle) manufactures chemicals, machinery, and silk [illegible]on, and is an important railway junction.

The greatest industry of Switzerland is probably that of catering for tourists. Until about fifty years ago the summer was the fit time to visit Switzerland; but to-day winter is perhaps even more popular. Ski-ing, curling, skating, and lugeing (tobogganing) in the brilliant sunshine, combined with excellent hotels, serve to attract tourists from all over the world. Doctors have found, too, that the strong sun and pure mountain air are good for certain illnesses, and there are many convalescent homes and sanatoria in the high valleys of the Alps.

See also Vol. I: SWISS.
See also Vol. IX: WINTER SPORTS.

SYDNEY. Hundreds of thousands of years ago, the continent of Australia tilted a little and its eastern coast went down. As a result, valleys were filled with the sea—and one became a branching sheltered harbour, winding inland for a dozen miles. On an inlet of this great harbour, which he called Sydney Cove, Governor Phillip founded, in 1788, the first British settlement in AUSTRALIA (q.v.). To-day, the city of Sydney, the capital of New South Wales and the largest city in the south-west Pacific, spreads over 300 square miles and has a population of over $1\frac{1}{2}$ millions—more than a fifth of the people in Australia.

Sydney is Australia's chief port and one of the great ports of the world. The dry dock, completed in 1945, is 1,070 feet long and can easily take the world's largest vessel. The harbour is the

SYDNEY. *Adastra Airways*

headquarters of the Royal Australian Navy, and during the latter part of the Second World War was the headquarters of the British Pacific Fleet. A bridge, built at a cost of £9 millions and opened in 1932, spans the harbour, joining the northern suburbs to the main city on the southern side. The floor of this bridge is 170 feet above the water, so that large ocean-going ships can pass under it (*see* SYDNEY BRIDGE, Vol. IV).

Sydney is a great and growing industrial centre, where textiles, both wool and cotton, aeroplanes, and paper are made, and where there are also railway workshops. It is also the chief airport of Australia, the starting-point of services to Britain and to New Zealand, as well as to cities in Australia. The Mitchell Library in Sydney houses the world's finest collection of books, letters, diaries, and other material on the history of Australia. The University of Sydney, founded in 1851, has more than 5,000 students.

The city is fortunate in having many ocean beaches quite close at hand. Best known are the beaches of Manly, Bondi, and Coogee. Hundreds of thousands of people throng to them on fine days, for surfing, sunbathing, and swimming, even though there is occasionally danger from sharks. Yachting is another popular sport, and a famous Club has its headquarters in Sydney Harbour.

SYRIA AND LEBANON. Another name for Syria and Lebanon is the Levant States, an area of land about half the size of France, lying south of Turkey, west of Iraq, and north of Palestine (Israel) and Jordan (*see* Map, p. 17). The Levant States were formerly part of the Ottoman Empire (*see* TURKS, Vol. I); but after the First World War they were mandated to France. In 1944 the independence of Syria and Lebanon as two separate states was recognized.

The coastal district has a 'Mediterranean' type of climate with hot, dry summers and warm, wet winters. Water is regarded as precious everywhere, for without irrigation crops could not flourish. The narrow coastal plain, 50 miles wide, is backed by mountains running from north to south—the Amanus in the north and the Lebanon in the south. Both fall eastward to the valley of the River Orontes, which flows north to the sea at Antioch. East of the Orontes rise the ranges of the Anti-Lebanon, which fall gradually to a plateau sloping to the Euphrates River in Iraq. This plateau is about two-thirds

THE MOUNTAINS OF LEBANON
Miss J. Allen

of Syria, and is mainly steppe and desert. In it dwell $1\frac{3}{4}$ million Moslem Arabs who are shepherds and farmers. Irrigation could make much of the steppe very productive; but marauding bands of desert Arabs make any attempt difficult.

DAMASCUS (q.v.), the capital of Syria, stands in the oasis formed by the Rivers Abana and Pharpha, the Biblical 'Two Rivers' of Damascus. It claims to be the oldest living city in the world. To-day it is a picturesque and busy town on caravan routes between the Mediterranean and the Persian Gulf. The Street called Straight runs right through the city from east to west, and in it JEWS and SYRIANS jostle against ARABS and EGYPTIANS and mingle with Kurds and BEDOUIN (qq.v. Vol. I).

Farther north are the cities of Homs and Hama with colourful and noisy bazaars. Aleppo, or Haleb, stands at the junction of three railways —the Syrian, and those running to Bagdad and to Palestine and Arabia. Caravans from Iraq make their way across the northern desert to Aleppo, and trade there with merchants from the Levant. It is also the centre of an important cotton-growing district. In the rich and fertile area of Latakia, olives, oranges, and tobacco are grown.

In the south part, on the borders of Jordan, is the mountainous Jebel-Druze region. The people are Arabs and form a political and religious sect of ISLAM (q.v. Vol. I). Vines are grown on the lower hill-slopes, and citrus fruits and cereals are cultivated in the valleys. As everywhere in Syria, there are ruins of cities and temples, of aqueducts and roads, built during the Roman Empire.

The most densely peopled part of the country, and the most productive, is the coast of the Lebanon region. This small independent state contains a remarkable variety of peoples of different race, culture, and religion. More than half the population, which numbers a million, are Christians; and the monasteries on the hill-tops were the refuge of Christians when Moslem Arabs swept through Syria in the 10th century. To-day Lebanon is culturally more developed than Syria, and owes much to French and American influence. The Lebanese speak Arabic, but are racially distinct from the Arabs, and are more in sympathy with the French than are the people of Syria. Beirut, the capital, is the most important port in the whole country, and a very French city. Tripolis, the next most important port, is the French terminus of the Iraq oil pipe-line. Though the old Phoenician cities of Tyre and Sidon have faded into insignificance as ports, they retain much of interest to the historian and poet. Lebanon is part of ancient Phoenicia, once famed for its traders and navigators. The wealth and skill of its makers of beautiful textiles were known throughout the ancient world (*see* PHOENICIANS, Vol. I). The Lebanese are still renowned for their silk-making, and behind Beirut is a region of mulberry-trees. Few of the ancient cedars of Lebanon are left: indeed the whole area has been stripped of trees. The Sanjak of Alexandretta in the north-west, with a population composed largely of Turks, was ceded to Turkey by France in 1939.

See also Vol. I: SYRIANS.

T

TABLE MOUNTAIN, *see* CAPE TOWN.

TADJIKSKAYA (TADJIKISTAN). This Soviet Socialist Republic, lying north of Afghanistan and Persia, and west of Sinkiang, used to be part of Russian Turkistan, but is now an independent republic in the U.S.S.R. (*see* Map, p. 459). It is very mountainous. In the eastern part are the mighty Pamir Mountains (*see* ASIA) which rise in parallel ranges to about 20,000 feet above sea-level, and are cut by valleys several thousands of feet deep. Stalin Peak (24,000 feet), the highest peak in the U.S.S.R., is at the northern edge of the Pamir Mountains, in a range called Peter the Great. A huge glacier almost 50 miles long, believed to be the largest in the world, sweeps down from this range.

Below the snow-line the mountain slopes are generally great stretches of bare red and grey rocks, broken by alpine meadows. Farther down there are forests of junipers and tall firs. On the lower slopes, too dry to support trees except in occasional clumps, grass and small shrubs are found. Boars, bears, foxes, panthers, and goats roam the mountains. In the valleys, and especially in the valley of the upper River Fergana in the west, cotton, rice, wheat, barley, and fodder crops are cultivated and there are vineyards and orchards. Some parts are irrigated. Sheep, cattle, goats, and horses are reared.

Until about 1925 there were no roads in Tadjikskaya, and the only means of communication was by yak. These sure-footed animals carried goods enormous distances by narrow, precipitous, and rocky tracks. To-day roads, built with great engineering skill and daring, cross the country and link it to the railway at Stalinabad, the capital.

Tadjikskaya has considerable industrial activity. Coal, gold, silver, lead, copper, and zinc

A VILLAGE IN TADJIKSKAYA, U.S.S.R. *Royal Geographical Society*

are among the minerals mined. Hydro-electric power serves the factories and mills at Stalinabad and Leninabad.

See also U.S.S.R.
See also Vol. I: SOVIET CENTRAL ASIAN PEOPLES.

TAIGA, *see* R.S.F.S.R., Section 2.

TANGANYIKA, *see* EAST AFRICA.

TANGIER. The Tangier International Zone is an oblong area at the north-west tip of Africa, some 10 miles from north to south and 15 from east to west (*see* Map, p. 5). It had its beginnings in the Roman province and town of Tingis. The present old walled town of Tangier was built in the Middle Ages by the Moors. It was taken by the Portuguese towards the end of the 15th century, and given to Britain as part of the dowry of Princess Catherine of Braganza when she married Charles II in 1662. It came under International Control in 1912. Much of the old Moorish town is still unspoilt. A new modern town with a large residential area has grown up outside its walls.

As Tangier stands nearly opposite Gibraltar, it commands the western entrance to the Mediterranean and is strategically a place of considerable importance in time of war. Its beautiful natural harbour is enclosed by an old mole built by the Portuguese. It is mainly a residential town, however, and French, Spaniards, English, Italians, and people of other nationalities have settled there. From the residential district on the hills behind the old town there are magnificent views both over the Straits of Gibraltar and inland to the Riff mountains.

THE FLAT HOUSE-TOPS OF TANGIER
Paul Popper

Tangier has a pleasant climate, especially in winter and spring. In summer, east winds blowing across the Mediterranean moderate the heat, while sudden violent rain-storms clean and refresh the city. Spring is very beautiful. In early March the fields are full of white and yellow jonquils and masses of magnificent purple Spanish irises. Mimosa and arum lilies are found in all the gardens. A little later the hill-sides are covered with white sweet-smelling flowers of the cistus shrubs. About this time the bee-eaters visit Tangier on their way southwards. These vivid little birds, brilliant blue-green and coppery red, with short swooping flight and shrill cry, haunt the cistus bushes for a few weeks and then disappear again. Through the summer, the purple bougainvillea spreads over the white Moorish buildings, and orange and lemon trees flower and fruit in the courtyards.

The Tangier Zone is mainly rather poor farming land. On market days, every Tuesday and Sunday, the country people bring in their produce—eggs, skinny chickens, mixed vegetables, fruit, and flowers—to sell in the town. Along the dusty roads come laden camels and donkeys—and the peasant women who, in Tangier, are still the main beasts of burden. The natives of both town and country are engaged in serving and exploiting in some way or other the European residents and visitors.

Tangier is governed by all the countries who signed the agreement by which the area became an International Zone. Their diplomatic representatives elect one of themselves as Administrator of the Zone, and he has, to assist him, a legislative body representing the different interests in the place. There is an International Court which deals with all matters of justice.

See also MOROCCO.

TASMANIA, *see* AUSTRALIA.

By courtesy of the Victoria and Albert Museum

A STREET IN TANGIER
Water-colour by Sir Ernest George (1839–1922)

TEHERAN
A gate of the city decorated with brilliantly coloured tiles with the royal crest of the lion and the sun in the centre
R. Gorbold

TEHERAN. The capital of Persia is Teheran. Though it is an ancient city, it has been the capital only since Agha Mohammed Khan, the founder of the Qajar dynasty, chose it for his residence in 1788. It stands 3,800 feet above sea-level, at the foot of the Elburz range of mountains, with the towering, snow-capped Demavend always in view. The climate is trying: in winter the thermometer may go down to zero; while in summer the heat in the middle of the day is almost unbearable, so that foreigners and well-to-do Persians retreat to their summer houses in the foot-hills of the Elburz Mountains. The city is 11 miles in circumference, and has a population of about one million.

The bazaars of Teheran are the largest in Persia, with the exception of those in Isfahan. They are a maze of covered passages with little shops on both sides. The passages open frequently into small courts or squares. Trades tend to have their own sections, and there are streets of shoemakers, butchers, coppersmiths, and other trades. In the bazaars a Persian can find every article he may require, from a saddle to a copper kettle. All the shops, however, are not in the bazaars: there are streets elsewhere in the city with shops resembling to some extent those of western countries.

Shah Riza (1925–42) made many changes in Teheran during his reign. He improved the roads, making a number of wide, tree-lined avenues, some of them asphalted. He encouraged the building of factories, and established a university, with faculties of literature, medicine, science, and law. In this university young men and girls attend the same courses, the proportion of girls being about 40%.

See also PERSIA.

TEMPERATURE, *see* HEAT.

TENNESSEE, U.S.A., *see* UNITED STATES OF AMERICA.

TEXAS, U.S.A., *see* UNITED STATES OF AMERICA.

THAILAND, *see* SIAM.

THAMES. As befits the waterway of the country's capital city, the Thames is the longest river in England, and also the best loved. From

THE THAMES NEAR CRICKLADE, A FEW MILES FROM ITS SOURCE
Beyond this the river is not navigable even in a small canoe. *G. M. Boumphrey*

its source in a meadow at Thames Head Bridge near Cirencester, it runs for some 210 miles before reaching the mouth of its estuary where, 18 miles across, it empties its waters into the North Sea. Its main importance commercially is in serving the port of London. The river is tidal as far as Teddington Lock, 18 miles above London Bridge. Above this, little but pleasure craft are to be seen, except a few strings of barges chugging along to Reading or Oxford. But in London and below, sea-going craft of all sizes carry on the business of a great seaport: ships drawing 20 feet reach St. Catharine's Docks at Tower Bridge, much larger ones dock at Blackwall, 5½ miles below, while the largest ocean-going vessels berth at Tilbury, a further 20 miles downstream. That part of the river near London Bridge is called 'The Pool', the length between the bridge and Blackwall, 6¼ miles, being 'The Port'. The tidal part of the river has been administered since 1908 by the Port of London Authority; all the upper part, above Teddington, by the Thames Conservancy Board.

In early and medieval days, the absence or disrepair of roads gave great importance to the Thames as a highway. Even in Stuart times, it was usually preferred to the rough cobbled streets or miry lanes, and many a stately procession of barges on its waters has carried important personages to their business or pleasure. Canute drove his invading craft as far upstream as Lechlade (where it is still navigable to barges, though rarely used by them). By the 18th century, navigation above London had become so difficult, owing to the existence of innumerable private locks and weirs, that control of the whole river was placed in the hands of Commissioners. These were replaced in 1857 by the Thames Conservancy. Since the 18th century, London has allowed its river to become hideously commercialized and has entirely neglected its possibilities as a means of local communication.

Once London is left behind, the Thames becomes more and more beautiful, with a character all of its own. High wooded banks alternate with lush green meadows set with willows, while every few miles charming towns

THE TOWER BRIDGE AND POOL OF LONDON
This is the highest point that large ships can reach. *The Times*

like Henley, Wallingford, and Abingdon still keep much of their 18th-century atmosphere. At Goring Gap the river passes close between the Berkshire Downs and the beech-wooded heights of the Chilterns. At Oxford the river is often called the Isis. Oxford itself makes little of its river, except for the reaches where the intercollege races are rowed—for the Thames is the centre of English rowing, as the annual OXFORD AND CAMBRIDGE BOAT RACE (q.v. Vol. IX) from Putney to Mortlake and the Henley Regatta attest. Above Oxford the surrounding country is flatter, but no less beautiful, as the river winds its way just north of the Vale of the White Horse, picking up the little Cotswold rivers, Evenlode, Windrush, and Coln. Above Cricklade, where it meets the ampler waters of the River Churn, the Thames is no longer navigable, even by canoe.

See also RIVERS; LONDON.
See also Vol. IV: RIVER NAVIGATION.

THAW, *see* HEAT, Section 5.

THUNDER-STORMS. These are of two types. The first is not uncommon in the stormy weather of a 'cyclone' (*see* WEATHER), and can be recognized by a rapid increase of the wind to gale force and its sudden change of direction —usually from south or south-west to west or north-west. The spring thunder-storms which, in Great Britain, are often accompanied by HAIL (q.v.) are of this kind. But the more familiar type is the thunder-storm which comes up in hot settled summer weather, with hardly a breath of wind until just before the deluge. For this to form, there must be a large amount of moisture in the air—probably drawn out from the ground by the hot spell. There must also be strong local heating of the air. The reflection of the sun's heat by some suitable area of ground is the usual cause; but there is at least one story of white men in the tropics starting a most successful thunder-storm by setting fire to the jungle—to their own great comfort on a very hot day, and to the awed amazement of the natives! There must also be no wind.

The locally heated air near the ground expands and, becoming lighter, rises by convection (*see* HEAT). The reduced pressure higher up expands it still further, which causes it to lose heat (just as air suddenly released from a bicycle tire feels cold). Being full of moisture it soon cools to dew-point or below, and its surplus moisture condenses as cloud. So far we have merely described the process by which the familiar woolly cumulus clouds of a fine summer day are formed (*see* CLOUDS, Fig. 5). These usually disappear at sunset, when the upward convection currents die down; but for a thunder-storm to take place something more is needed. The amount of water-vapour condensing must be so great that the latent heat released by the condensation warms the air enough for it to rise still higher by convection. And so the process continues, higher and higher, until there is a great towering thunder-cloud piled up 5 miles high (*see* CLOUDS, Fig. 6). This looks motionless to us on the ground; but airmen who have flown through these clouds know better. They tell of violent gales of winds raging for hundreds of feet upwards and downwards, or eddying round in wild circles, and of gusts violent enough to tear the wings off their aircraft. What is going on in a cumulonimbus cloud is, in the words of a famous meteorologist, 'a gigantic, if comparatively slow, explosion of moist air, the latent heat of the moisture acting as fuel'.

Fig. 1 is a sectional view of a thunder-storm, the arrows showing the directions in which the main wind-currents inside the cloud are believed to blow. It illustrates how, once the convection

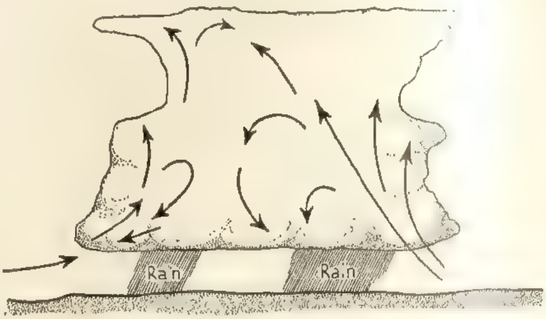


FIG. 1. SECTION THROUGH A THUNDER CLOUD
After G. Kimble and R. Bush, 'The Weather', Penguin Books

process has started, more and more moisture is sucked up into the cloud from below, carried aloft and condensed into water. This clearly cannot go on for long without something coming down again. Yet the upward currents of air may be so swift that rain cannot fall down through them—by the time the drops are big enough and heavy enough to move downwards,

they are so large that they break into small drops again and get carried up once more. A severe thunder-storm is capable of supporting something over a quarter of a million tons of water in the air. Eventually, however, the drops multiply to such a degree that they extend beyond the limits of the rising currents—and down they come. If anything occurs to cut off the supply of heat which began the convection process, or if the storm is raised bodily by passing over mountains, the whole system may collapse more quickly in a 'cloud-burst' and perhaps cause great damage (*see* RAIN; HAIL).

The way in which electrical charges are built up in thunder-clouds is not fully understood (*see* ELECTRICITY IN NATURE), but the continual breaking up of raindrops plays a part in it, and so does friction between the ice particles at higher levels. For, as Fig. 1 shows, the temperature in the upper part of the clouds is far below freezing-point. Air is so bad a conductor that enormous electrical pressure is needed before a spark can jump across any great distance. Lightning-flashes, which are simply enormous electric sparks, can jump 5 or even 10 miles, and to do this they need a pressure about one million times as great as that used in the electric lighting of our houses. Most of the flashes in a thunder-storm take place from one part of the cloud to another: comparatively few strike down to the ground. Some strike upwards to the 'heaviside layer' of the ATMOSPHERE (q.v. Fig. 1) and some pass from cloud to cloud. The flash follows the path of least electrical resistance, which is usually a jagged line. It is all over in, at most, a tenth of a second; but in that time an enormous power of electricity has coursed forwards and backwards along the track, generating such terrific heat that at its point of contact with the earth, timber is charred, metal may be melted, and even solid rock fused. As well as generating light and heat, a lightning-flash emits the form of RADIATION (q.v.) which we know as wireless waves, and the crackles and bangs heard from our loud-speakers are a familiar accompaniment to any local thunder-storm. They have been heard as far as 4,000 miles away from the flash that caused them.

The sound we call thunder has a quite different origin. It is caused by the violent expansion of the air owing to the intense heat of the flash, and its subsequent contraction. No wonder it sounds like heavy gun-fire, which is

FORK LIGHTNING OVER PARIS
The Times

also due to the rapid expansion of gases. Though the lightning itself is all over in a fraction of a second, the sound of the thunder may go on rolling and rumbling for very much longer. This is partly the result of echoes from houses, trees, hills, and even clouds, and partly because the noise comes from different places along the path of the flash and so—since SOUND (q.v.) travels very much more slowly than electricity or light—reaches the listener at different times. It is easy to calculate how far away lightning is by counting the interval between the flash and the thunder. Sound travels a mile in about 5 seconds; so if you make the time 15 seconds; the lightning is 3 miles away, and so on. There is not very much danger of being struck in a thunder-storm unless you happen to be the highest object in the neighbourhood or standing on high ground—or, above all, unless you have been so foolish as to take shelter under tall isolated trees. Indoors you are comparatively safe; but it is wiser to keep away from the fire-place, because the chimney is the most likely place to be struck. Windows and doors are as safe as anywhere else, nor will holding a knife

or other small metal object increase your danger. On the other hand, many a golfer has been struck when swinging a steel club in the open. There is some comfort in the saying 'If you heard the thunder the lightning didn't strike you. If you saw the lightning it missed you. And if it did strike you, you don't know it.'

Sheet-lightning is either the reflection on the clouds of distant lightning or else flashes inside or upwards from the cloud itself. There is also a form called 'ball lightning', which is fortunately rare, because it is extremely destructive. Many people in thunder-storms have seen what they describe as a luminous ball, in size anything from a few inches to a yard in diameter. This floats slowly along, doing no damage until it meets a solid object, when it shatters it with all the force of a high explosive shell. Sometimes it bursts with a loud explosion either then or later; sometimes it gradually grows smaller and disappears. Ball lightning seems to follow a draught of air—cases have been reported of it having entered a house by one door and left by another without causing any damage. Its nature and origin are complete mysteries, and, unlike fork or sheet-lightning, no imitation of it can be produced in an electrical laboratory.

Thunder and lightning were regarded with great awe in ancient times, being usually regarded as the direct action of the gods. Battles have been lost because the attackers have interpreted a timely thunder-storm as divine help for the other side. To the Greeks and Romans, the thunder-bolt was the weapon of the Father of the Gods himself, Zeus or Jupiter, while in the Norse Myths, Thor was the god of thunder and struck down his enemies by hurling at them his magic hammer, which had the property of coming back to his hand. One good point must be credited to lightning: in burning its way through the air, the flash combines with quantities of nitrogen, which is of great benefit to plant life. The gas comes down to earth dissolved in the raindrops and is absorbed in the soil (*see* NUTRITION OF PLANTS, Vol. II). It has been calculated that by this means the earth receives no less than a hundred million tons of this valuable chemical fertilizer each year.

TIBER, *see* ROME.

TIBET (or BOD-YUL, as the Tibetans call their country). This mountain country lies in central Asia, with China to the east and north and India and Burma to the west and south (*see* Map, p. 229). It is the highest country in the world, formed by a vast inland plateau over 10,000 feet high, surrounded by the Kun Lun Mountains in the north, and the Great Himalayan Range on the south (*see* HIMALAYAS). Tibet covers an area of 463,000 square miles, which is about four times the size of Great Britain. Mount EVEREST (q.v.), the highest mountain in the world, is within its borders. The land is studded with innumerable lakes, ranging in size up to the Great Koko Nor, which covers 16,000 square miles. Tibet is also the nursery of mighty rivers whose sources lie close together in the east of the country—the YELLOW RIVER, the YANGTZE, the Mekong, Salween, and IRRAWADDY (qq.v.)—and, in the south, the Tsang-po, or upper Brahmaputra, and the INDUS (q.v.).

The climate throughout the uplands is intensely dry, clear, and cold, with icy winds. During the short summer, however, the sun sends the thermometer as high as on our hottest days in England, though at night it may drop by as much as 70° or 80°. Apart from a few showers of rain during the Indian MONSOON (q.v.), the only moisture reaching a great part of the country comes in the form of melted snow, and where this can be put to use by artificial irrigation, good crops can be grown. Owing to the high altitude and the intense process of evaporation, one scarcely ever perspires. The dry air and sunshine are healthy; infectious diseases are rare, tuberculosis almost unknown, and ordinary cuts and sores do not fester.

In contrast with the treeless and bleak plateau, there are on the borders of India and China, deep, forest-clad valleys, where the vegetation is semi-tropical. These are the hunting-grounds of botanical explorers, who in the last half-century have brought many of the rarest shrubs and flowers now flourishing in our gardens, especially varieties of rhododendron and azalea.

Tibet is rich in animals, including the snow leopard, wild sheep, ibex, kiang (wild ass), and great panda, as well as lynxes, wolves, foxes, otters, stone-martens, and marmots. There is also a great variety of bird life.

The country has no railways. It has, however, ancient and much-used trade-routes, for the Tibetans are great travellers and traders

THE MULES OF A TEA CARAVAN CLIMBING A PASS BETWEEN CHINA AND TIBET
Paul Popper

(*see* TRADE ROUTES, Vol. IV). These trade-routes mostly fan out from the capital, Lhasa, towards India in the south, China in the east, and Turkistan to the north. They have to surmount formidable obstacles, because the country is hemmed in with mountains. The routes to India go over passes from 14,000 to 18,000 feet high, where men and beasts find it difficult to breathe; while those leading to China have immense canyons to cross, usually spanned by grass-rope bridges, sagging and swaying in a way terrifying to the inexperienced traveller.

Merchandise is carried by pack-ponies or yaks. The yak is an indispensable creature, amazingly hardy, and able, as no other animal can, to endure the rarefied atmosphere prevailing on the high passes. He moves slowly, however, and the trip from Lhasa to Tachienlu, the principal Chinese trade-mart, takes well over three months. The trade consists chiefly of wool (both yak's and sheep's), borax, and musk, which are exported in exchange for tea, cotton goods, flour, and other of the commoner necessities of life—though in recent years the Tibetans have begun to import such modern things as wireless equipment.

The country is rich in minerals, very little of which can be commercially exploited owing to the lack of proper roads and transport. The mineral products include gold, silver, iron, copper, zinc, borax, salt, and sulphur. The Tibetans have guilds of able craftsmen who make beautiful ornaments and articles used in their religious ceremonies in the monasteries. The weaving of cloth and carpets on primitive looms is a general industry of the people.

See also Vol. I: TIBETANS.

TIDES. Twice a day tides advance and retire on most ocean shores. On low, gently sloping coasts the mark left by the last high-tide can usually be seen by the line of flotsam left there, and on steeper rocky coasts, low-water mark, the line below which the water never falls, is generally shown by the limit of growing sea-weed. These periodic rises and falls of sea-level are due

to the gravitational pulls of the Sun and Moon on the seas and oceans of the Earth (*see* GRAVITATION). We will trace the effect of the Sun, because it is more easily described; the Moon affects tides in a similar way, but being much closer to the Earth, acts more than twice as strongly, in spite of its smaller size.

It is easy to see that the gravitational pull of the Sun must draw the water on that side of the

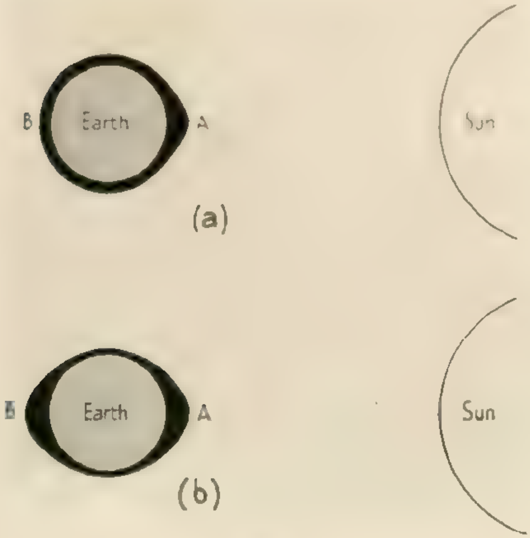


FIG. 1

Earth nearest to it into a bulge, as shown in Fig. 1 *a*, since gravity acts more strongly over a shorter distance than over a longer, and A is nearer the Sun than B. But if this were all that happened, we should get only one high tide each day; whereas in most places we actually get two. The true position is shown in Fig. 1*b*, where it will be seen that there is a bulge at both A and B.

To understand why this is so, we must remember that the Earth is rotating round the Sun and, just as the water in a bucket which a man is swinging round and round his head would, if the bottom of the bucket gave way, fly out, owing to what is commonly called 'centrifugal force' (*see* MOTION), so the water on the Earth would fly off if some stronger force were not restraining it. This force is the Earth's gravitation. As a matter of fact, if the gravitational pull of the Sun were removed, the whole Earth—and not only its water—would, for the same reason, fly away into space. As it is, however, this centrifugal force is exactly balanced by the pull of the Sun, and so the Earth continues to revolve in its orbit. Now the centrifugal pull is the same at all points on the Earth's surface; but we have already noted that the gravitational pull is greater at A than at B. So the place where the two pulls balance (as we know they must do for the Earth as a whole) must be half-way between A and B. At A then, the Sun's pull is stronger than the centrifugal force and draws the water into a bulge; but at B the centrifugal force wins the tug of war and makes another bulge, as in Fig. 1 *b*. As the Earth turns on its axis these two bulges sweep round the globe, and so we get, not one, but two tides a day.

Now, we must remember that the Moon also is exercising a gravitational pull on the seas—a pull of considerably greater force than the Sun's. When the pulls of both Sun and Moon are in the same direction, that is twice in each lunar month, at a full moon and at a new moon, we get not only abnormally high, but also low tides (*see* Fig. 2*a*); when the Moon's pull is at right angles to that of the Sun, at the first and third quarters, we get abnormally small rises and falls, called 'neap' tides (*see* Fig. 2*b*). The times of these spring and neap tides can be calculated approximately for a specific place—which may be a matter of some importance when the tides are depended on for bringing boats up the harbour.

In actual fact, the tides do not act as simply as described, for several reasons. The most im-

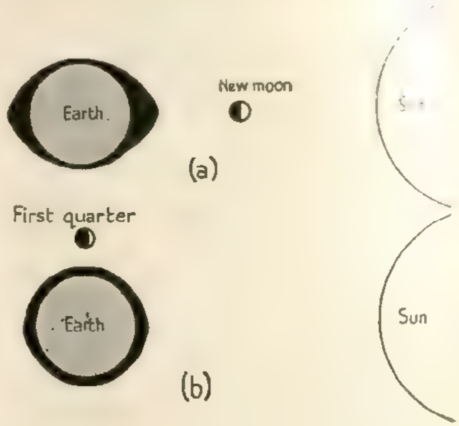


FIG. 2

portant of these is that the flow of water round the globe is to some extent obstructed by the land-masses and by the friction against the

[illegible] shallow seas. One result of this is that [illegible] tides of the world are on an average from [illegible] to two days behind time. There are many [illegible] abnormalities, such as places which [illegible] one high tide a day and others with four [illegible] channels of water which have high tide along [illegible] shore while it is low tide on the other —as [illegible] happens on the opposite coasts of [illegible] and Holland.

[illegible] the tidal wave affects all ocean water, it [illegible] greatly from place to place. On the shore [illegible] the North Atlantic there are two tides, prac[illegible] equal in size, each day. On the [illegible] coast of North America, however, one tide [illegible] very much larger that the other scarcely [illegible] to exist. Gently shelving coasts and gulfs and bays offer so much resistance to the oncoming wave that it piles up as it is slowed down [illegible] and consequently these areas have the [illegible] difference in level between high tide and low tide. The famous high tide of the Bay of [illegible] Nova Scotia has a range of about 5[illegible] The strong tide from the deep waters of the [illegible] Ocean churns into the deep trough of the [illegible] and piles up as the bay narrows. At low [illegible] the river St. John flows down into the bay [illegible] a small waterfall, made by a bed of ro[illegible] the entrance to the river gorge. At high ti[illegible] ever, the waters of the sea rush up the riv[illegible] such force that they drive up over the rocks, making the remarkable Reversible Waterfall

Sometimes the flow of tide in channels is very rapid. Then, when the tide turns, the two opposing currents of water meet and a whirlpool may be created. The Maelstrom, a very violent whirlpool off the Lofoten Islands of Norway, is caused by the meeting of tidal streams racing through channels between the islands.

In some estuaries, the river water meets the incoming tide with such violence that a huge tidal wave piles up and rolls upstream. In the Severn this wave is called the 'bore'; in the Trent it is the 'eagre'; in the Seine, the 'mascaret'; and in the Amazon, the 'pororoca'.

The Mediterranean Sea is practically tideless. Julius Caesar, in fact, only first learnt the existence of tides when he came to Britain. Mediterranean tides vary only about 6 inches between high and low, because the Mediterranean is practically an inland sea, protected from the full effect of the ocean tides by the narrow Straits of Gibraltar. The tidal effect of a completely inland sea, like the Caspian, is too small to be measurable.

Tides are important to shipping because at high tide ships can often get into a port or harbour by a channel which at other times would not be deep enough. This is of special importance to the few ports which have four or even six tides per day. Poole and Weymouth and several Dutch ports have four tides. Le Havre and Southampton have six. In the case of Southampton, the Solent affects tides so that high tide comes in three successive phases, lasting altogether for over three hours.

There have been several schemes for using tidal currents to generate power. Water-wheels have been worked by tidal ebb and flow just as they are worked by river current in some old corn-mills. With another method the tide causes a float geared to machinery to rise and fall in a tidal chamber: here, the amount of gearing necessary is a great drawback. The most satisfactory schemes are those in which the tide fills a basin, and so gives a head of water which can be made to drive turbines (*see* WATER-POWER, Vol. VIII).

See OCEANS.

TIGRIS RIVER, *see* IRAQ.

TIMBUKTU, *see* SAHARA DESERT; SUDAN.

TIME. Time has been measured on the Earth for many thousands of years (*see* CALENDAR), and most people take it for granted, regarding it as a 'never-ending stream' and leaving it at that. NEWTON (q.v. Vol. V) wrote of it: 'Absolute, true, and mathematical time, of itself, and from its own nature, flows equally and without relation to anything'—and for more than 200 years this statement was accepted by scientists as being so obviously true that no proof could be needed. Before we go on to see how greatly our ideas about time have changed in the present century, let us look more closely at the older definition. How can anything be said to be flowing 'without relation to anything'? It is only by comparing the movement of anything with some point of reference—such as the bank, in the case of a river—that we can know that there is a flow at all. Astronomers and physicists would be glad of a definite point of reference for relating the flow of time—an exact moment of NOW, the same all through the Universe. It is only in

the present century that measurements, using the velocity of light, have become accurate enough to show that no such moment can be fixed. A completely new approach has had to be made to the idea of time. Instead of regarding it as 'flowing equally and without relation to anything', we now have to regard its existence, as well as its rate of flow, as dependent on relationships or relativity. The speed of time, in fact, depends on who is observing it and from where.

We may think of time as measured by a clock, the speed of which is controlled by a pendulum or balance-wheel. Now it is one of the laws of RELATIVITY (q.v.) that the mass of anything increases as its speed increases. If we were able to place a clock on a star moving at such a speed that its 'inertia' or resistance to movement increased measurably, the pendulum or balance-wheel of the clock would swing more slowly; and it would appear to someone not moving at that speed that the clock was losing time. To someone also on the star, however, and moving with the speed of the clock, it would seem to be keeping perfect time, since any other clock moving at this speed would be keeping the same time. It is impossible to say that one observer is right and the other wrong. Both are reading time, as relative to them, perfectly correctly.

In everyday life, of course, nothing ever travels at speeds that would make differences in time noticeable, even with the most accurate instruments. Even in the Solar System they are hardly noticeable, and the Astronomer Royal takes a NOW moment each day from the position of the sun which is quite accurate enough to serve the whole world as a standard of time. But astronomers, who have to deal with movements of stars at such immense distances that their light, travelling at 186,000 miles per second, may take millions of years to reach us, and physicists, who may have to deal with atomic particles which disintegrate after an existence of only 2 millionths of a second, and which travel at nearly the speed of light itself, have found it very necessary to be more exact in their measurements and calculations. The new ideas on time have been reached chiefly as a result of the difficulties that such scientists met as long as they tried to work by the old, 'common-sense' rules.

Measurements of distance have become similarly involved, and ordinary geometry has been found to be inadequate when applied to problems where immense speeds and distances are concerned. A solution has been found in a new kind of geometry. Instead of measuring the Universe by the usual three dimensions of length, breadth, and depth, this deals with it as having four dimensions. The new fourth dimension of the 'space-time continuum', as it is called, is time. But it is time with a difference, because to a certain extent it is interchangeable with space. This appears inconceivable to us at first sight—and yet it is not quite so strange as it seems. We might as easily say of a man in a motor-car that he lighted a cigarette at the village of A and threw the end away in the village of B, as that he lighted it at two o'clock and finished it at a quarter past.

See also CALENDAR; RELATIVITY; SPACE.

TIN-ORE, *see* METAL ORES; *see also* Vol. VII: TIN-MINING.

TOKYO, capital of the Japanese Empire, was, before the Second World War, the third largest city in the world, with a population of nearly seven millions. It has grown rapidly since Japan came into contact with other nations in the middle of the 19th century, and is still to a great extent a patchwork of villages joined to each other by the trams and buses that rattle down long straggling streets of one-storeyed, open-fronted shops and squalid wooden houses. The great parks, the innumerable temples and shrines surrounded with splendid trees, the wide Palace Gardens, the miles of tree-bordered moats round the inner city, give to all but the business quarter a country look, especially beautiful at the seasons of spring flowers and autumn tints.

There is still much that belongs to old Japan. The flower man goes round with his laden barrow; the goldfish seller carries his wares in two bowls hanging one from each end of a pole balanced on his shoulder; and the man who sells bean curd, a favourite delicacy, calls his customers with a peculiar nasal scream. Each temple keeps its monthly feasts according to the calendar of the zodiac, when religious plays and dances are performed in the temple grounds and evening sees the streets near by filled with stalls selling everything from wooden clogs to singing crickets in bamboo cages.

Before the First World War, central Tokyo had already a number of big modern buildings in European or semi-European style, including a fine railway station, one of the largest theatres

THE RIVER FRONT OF TOKYO WITH TOKYO BAY IN THE BACKGROUND. *Paul Popper*

in the world, and several many-storeyed department shops on American lines. After the great earthquake of 1923 had destroyed much of Tokyo, the city was rebuilt with many more 'foreign-style' shops and offices. In the Second World War allied bombing did great damage to the central and business quarters of Tokyo. But the Japanese are used to the destruction of their cities through earthquake, fire, and typhoon, and within a year of the end of that war the ordinary life of the town was very much as it had been before.

The port of Yokohama, with over 700,000 inhabitants, is 18 miles from the centre of Tokyo, of which it is almost a part. This was one of the original 'Treaty Ports', in which non-Japanese merchants were allowed to live and trade after the opening of the country to foreigners in 1853. It is one of the great ports and trading centres of eastern Asia.

See also JAPAN.

TOPAZ. In Sanskrit, topaz means 'fire'—and when cut and polished this gem-stone has a very fine lustre. The word is often applied loosely to describe any yellow stone. Scottish topaz is yellow quartz; Oriental topaz is yellow sapphire; but Brazilian topaz is the true topaz—which is harder than either yellow quartz or yellow sapphire.

True topaz occurs in many colours, ranging from yellow to sherry, and in pale blue, pale green, and, more rarely, pink and red. When heated, yellow topaz loses its colour completely. Most pink topazes have been made pink artificially by the heating of poor-coloured brownish-yellow stone: when they cool, they have a pinkish colour which is permanent.

TORNADO. This is a very violent and concentrated wind-storm formed by air whirling rapidly upwards. It is usually greyish in colour, and looks like a gigantic elephant's trunk swaying and twisting from the clouds to where its tip touches the earth. It rushes across country in a fairly straight line at a speed which is usually about 25 miles per hour but may be as low as 7 or as high as 100, and is accompanied by a deafening noise. Luckily its path is rarely more than 40 miles long and a quarter of a mile wide, and it seldom lasts more than an hour.

The exact causes of a tornado are uncertain; but it is known that before a tornado can form, a mass of warm moist air must meet a mass of cold dry air (*see* WEATHER). When the two masses meet, the warm moist air rises, while the cold dry air descends, and the upward spiral movement, characteristic of tornadoes, is started. A tube of air whirling at great speed—probably reaching 400–500 miles per hour—results. Inside the tube, pressure is reduced so much that a partial vacuum is formed.

Thus a tornado is accompanied by three forces, each of which can cause great damage:

A TORNADO, MINNESOTA, U.S.A.
Lusille Handberg

there is the pressure of the whirling air, the updraught caused by the rapidly rising air, and the partial vacuum of the centre of the tube.

The first of these forces can drive normally harmless things at such a speed that they become dangerous missiles. Sand and gravel have been given the force of shot-gun pellets, and even a weed has been known to be embedded in a plank of wood. A horse was killed by a corn-cob which was driven into its skull, and in Calcutta a bamboo cane was reported to have been driven through a wall 6 feet thick, made of mud faced on both sides with brick. Even iron has been pierced by pieces of wood, and there is a story that a large pig was found transfixed lengthwise by a piece of wood 7 feet long and 6 inches square.

The updraught of a tornado is immensely powerful and can pick up a large object, carrying it high in the air across country before setting it down again. The object may be put down almost unharmed, because it falls slowly to earth through an ascending current of air—just as a balloon might fall slowly if a child blew against its underside. Cows have been lifted in this way, and a horse was carried 2 miles and then set down alive. A man to whom this happened said that as he was sailing through the air, he grasped a horse which was also sailing along—and certainly, when he came down to earth, he had a handful of horse-hair in one hand! The updraught can be so powerful in a large tornado that steel bridges have been wrenched off their foundations, trees plucked out of the ground, and trains lifted from their lines.

The partial vacuum in the centre of a tornado has some strange results. If a tornado straddles a house, the vacuum causes the air inside the house to rush out with explosive violence, and the house may be destroyed—much as a tomato bursts if you put it in the oven without first pricking the skin. The vacuum can cause corks to fly out of bottles, feathers to fly out of chickens, and wool to come off the backs of sheep.

Tornadoes occur in every continent, but are most frequent in the southern states of the U.S.A., where, in 1930, 245 were reported. England has had small tornadoes occasionally: in 1928 one crossed London from near Victoria to Euston, doing damage estimated at about £15,000. That this was a relatively small one is apparent from the fact that one American tornado killed 250 people, injured many more, and did £3,000,000 worth of damage. In regions where tornadoes are prevalent, special precautions are taken: many houses have reinforced

basements, called cyclone cellars, and there are underground vaults in which people take refuge when a tornado is known to be approaching.

TOURMALINE. This is rather a complicated stone to describe. Its composition varies slightly, so that it is found in a variety of colours, some stones even being one colour at one time and another at some other. Tourmaline is generally found in hexagonal crystals. It varies in transparency, the black variety being practically opaque. It has the property of polarizing LIGHT (q.v.).

All tourmaline has two colours, according to the angle from which it is viewed; and all of it, if rubbed or heated, attracts small pieces of paper—it is said that Dutchmen used to make use of this property for getting the tobacco ash out of the bowls of their pipes.

The different varieties have different names, black being called 'schorl', pink or red 'rubellite', green 'Brazilian emerald', blue 'Brazilian sapphire', and yellow or yellow-green 'Ceylon peridot'.

Tourmaline is found in many plutonic and metamorphic rocks in various parts of the world. A very old source is near Mogok, the only mining centre in Upper Burma. Many of the stones from this area went to China to become the buttons of mandarins' hats.

See also ROCKS; Colour Plate opp. p. 288.

TRANSJORDAN, *see* PALESTINE; JORDAN.

TRANSVAAL, *see* SOUTH AFRICA.

TRANSYLVANIA, *see* CARPATHIANS; ROUMANIA.

TRINIDAD, *see* WEST INDIES.

TRISTAN DA CUNHA. This group of South Atlantic islands, lying almost midway between South Africa and South America (*see* Map, p. 322), is one of the most remote outposts of the British Empire. The only contact the islanders have with the outside world is the occasional visit of a steamer. There is no harbour or safe anchorage except in fair weather, and very often dense fogs, fierce currents, and heavy seas prevent ships from delivering mail and stores.

The islands are named after a Portuguese admiral who discovered them in 1506. In 1816 they were annexed by Britain, and a garrison from Cape Colony arrived to occupy them. In the following year, when the troops were withdrawn, Corporal William Glass of the Royal Artillery asked to settle on the island with his wife and two children. He was joined by two naval men, and, some years later, by some natives of St. Helena, Dutchmen, Italians, and Americans. To-day there are 200 islanders, descended from this mixed blood, and speaking English with a very limited vocabulary. They seem to be content with their lonely life, and, with few exceptions, have repeatedly refused to leave Tristan da Cunha.

TRISTAN DA CUNHA
Canadian Pacific Photograph

The main island, Tristan, is an extinct volcano, rising sheer out of the sea to a height of 1,000 feet. The crater of the volcano is filled with a lake of ice-cold water, making a natural reservoir. The only habitable part of the island is in the north-west corner, on the grassy slopes of a narrow plateau beneath the cliffs. Here the islanders grow wheat and potatoes, and rear cattle, sheep, pigs, and poultry. Their houses are built of large slabs of stone cut from the cliffs, with thatched roofs of coarse flax. For transport over the rough cart-tracks they use donkeys with panniers, and a few wooden-wheeled carts drawn by oxen.

The other islands, Inaccessible and the three Nightingale islands, are the home of numbers of penguins and sea fowl, though recently a little farming has been started on Inaccessible.

TROPICS, *see* CLIMATE, Section 2 (*a*).

TUNDRA, *see* R.S.F.S.R., Section 2.

TUNISIA. This most easterly of the three countries of French North Africa lies directly south across the Mediterranean Sea from Sardinia. The channel between the south-west corner of Sicily and the north-east corner of Tunisia is the narrowest part of the central Mediterranean. Tunisia is a Protectorate of France, and lies between the French Protectorate of ALGERIA (q.v.) and Tripolitania (*see* LIBYA). It is about 130 miles from east to west, and 360 miles from north to south (*see* Map, p. 5).

Tunisia was perhaps more important, and certainly had a larger population, in ancient times than to-day. The PHOENICIANS (q.v. Vol. I) made a settlement at Carthage, near the present capital, Tunis, as early as the 12th century B.C.; and as the Phoenicians declined, Carthage grew in wealth and power. Under their great general HANNIBAL (q.v. Vol. V), they built up an empire which th[illegible]l Rome itself. After the overthrow of H[illegible]l, Tunisia became a Roman colony. Th[illegible] that ships can sail from Rome to Carthag[illegible]ut being out of sight of land for more th[illegible]ry short time made it suitable for early [illegible]ion and development. There are the [illegible]t many Roman towns or villas scat[illegible]er the country—at El Djem, for instan[illegible]he ruin of the third largest Colosseum in [illegible]d. The water-supply of Tunis comes [illegible] moun-tains by an aqueduct 80 miles l[illegible]ich was originally built in the reign o[illegible]mperor Hadrian, in the 2nd century [illegible] bring water to Carthage. At Carthag[illegible]water is still stored in Roman cisterns w[illegible]l walls of masonry 7 yards thick.

The present inhabitants of Tun[illegible]f whom there are about 2½ millions, ar[illegible]bs (q.v. Vol. I), either belonging to Be[illegible]ibes or descendants of the Arabs who s[illegible] North Africa from the 7th century onw[illegible] About A.D. 670, the Moslem armies conv[illegible]Tunisia to the ISLAM faith (q.v. Vol. I). S[illegible]o miles south of Tunis stands the Moslem [illegible] City of Kairwan, which for more than 1,2[illegible]ars was the Moslem capital of North Africa[illegible]e great Moslem University, 'the Mosque [illegible] Olive

AN ARAB CARAVAN IN TUNISIA
Lehnert and Landrock

Tree', and Kairouan in Tunis is the seat of learning of a very narrow sect of Islam. Tunisia is the home of some 100,000 Arabic-speaking Jews, and there are also a great many Italian and Maltese settlers. Since 1881, when Tunisia became a French protectorate, many French officials and colonists have settled there.

The north-west of the country is occupied by tangled hills and mountains, the eastern end of the Atlas ranges. They are mostly barren or covered by scrub, though to the west are large forests of cork oak. Along the coast lies a very fertile plain, where corn, vines, citrus fruits, and vegetables are grown. Near Sfax, on the east coast, enormous groves of olive-trees have been planted in carefully cultivated rows. Olive oil is the cooking fat of the country and is also one of its chief exports. In central Tunisia there are several vast shallow salt-lakes which dry up almost entirely in the hot season. This is a desert country where MIRAGES (q.v.) are often seen. Further south stretches the great SAHARA DESERT (q.v.), where hardly anything grows except in the fertile oases. It is on these oases that the famous Tunis dates grow.

The climate of Tunisia is sub-tropical—very hot in summer, and in winter cold only in the mountains. There is usually no rain from April to October; but in the north there is plenty of surface water, though this is generally brackish.

TURKEY. This country is roughly quadrilateral in shape, about 1,000 miles in length and 400 in width. It lies in Asia, except for a small triangular peninsula west of the Bosporus and north of the Sea of Marmara and the Dardanelles (*see* BLACK SEA). The Black Sea bounds it to the north, the Aegean Sea to the west, and the Mediterranean Sea and the Levant States and Iraq to the south (*see* Map, p. 17).

Most of Turkey is highland. In the west, the Anatolian Plateau varies from 1,500 to 3,000 feet above sea-level. In the east and along the southern rim of the plateau, mountains rise to 6,000 feet. Semi-arid desert occupies large areas of this highland and all of it is baked brown by the sun in summer. Deep snow covers much of it in winter. Millions of fat-tailed sheep and silky Angora goats are pastured on it. The coastal plains of the south and west coasts, and the valleys which lead to them, are fertile and well watered, and the coast is well provided with protected harbours and sheltered coves. Climate is temperate and rainfall adequate. On the north, bordering the Black Sea, the coastal belt is narrower, and the climate—except at its eastern end—colder and less agreeable. The valleys, though fertile, are constricted, the rivers are turbulent, and large areas are covered with forests. Harbours on this coast are few and ill protected.

A considerable number of rivers are shown on maps of Turkey. In spring many of them are foaming torrents—frequently causing widespread devastation; in summer, however, most of them either shrink to a trickle or disappear completely. The Kizil Irmak, the longest river in Turkey, is salt for nearly half its course.

The greater part of Turkey is pasture land, less than 15% being cultivated. On the plateaux and hills of the interior are kept some 40 million sheep, goats, and cattle, yielding wools and mohair unexcelled in quality. The soil is generally fertile, and in the valleys and irrigated plains it produces good crops, but the methods of cultivation, particularly in the remoter areas, are primitive. Farms are mostly small and are usually worked by the owner and the members of his family.

Turkey is essentially a bread-eating country, so that wheat takes precedence over all other crops. About 4 million tons are produced in a normal year—about equal to the production of Australia. Turkey also produces about $2\frac{1}{4}$ million tons of excellent barley and another $1\frac{3}{4}$ million tons of other cereals.

Industrial crops are very important, both as the basis of manufactures and for export. The most valuable is tobacco, which is grown principally in the coastal areas of the west and north. Cotton is next in importance, a third of it being long staple cotton similar to that grown in the United States, while the remainder is short staple, like Indian cotton. The growing of sugar-beet is a recent innovation: yet Turkey has already become almost independent of foreign supplies of sugar. Turkish figs, raisins, olives, and hazel-nuts are renowned throughout the world. Figs and sultana raisins are produced in the west coastal areas and are exported mainly to Britain.

Turkey has been called a country rich in poor mines. This, in a broad sense, is true. Nevertheless, she possesses important deposits of at least two minerals, coal and chromium. Lignite,

THE BOSPORUS FROM THE EUROPEAN SHORE
Medieval castles guarded the narrow channel into the Black Sea. *Paul Popper*

iron, sulphur, copper, lead, silver, and other minerals are also mined. Oil, too, has been found, but so far no important field has been discovered.

The census of 1945 showed that the population is nearly 19 millions, of whom 860,000 live in ISTANBUL (q.v.), the largest city, 198,000 in Izmir, and 227,000 in Ankara, the capital. There are half a dozen towns with between 50,000 and 100,000 inhabitants. Three-quarters of the population live in villages and work on the land. 85% of the people are Turks. 9% are Kurds, a hardy people who live in the highlands of the south-east. The remainder are Arabs, Greeks, Armenians, Jews, and Europeans.

Turkey is potentially a rich country, but it is only partially developed, and the people generally are poor.

See also Vol. I: TURKS.

TURKMENSKAYA (TURKMENISTAN). The Soviet Socialist Republic of Turkmenskaya lies north of Persia, on the east coast of the Caspian Sea (*see* Map, p. 459). The greater part of its area is semi-desert or desert, roamed by nomads with herds of cattle, sheep, and goats. Cultivation is limited to oases, where cotton, wheat, mulberry-trees (for silk-worms), and orchards can be irrigated. At Ashkhabad, the capital, there are cotton, silk, and woollen mills, and meat-packing stations. The Kara Kum Desert, which forms a large part of Turkmenskaya, has sulphur and silver deposits, and coal, copper, and lead-mines. There are oil-wells near the Caspian Sea.

See also U.S.S.R.
See also Vol. I: SOVIET CENTRAL ASIAN PEOPLES.

TURQUOISE. The unusually brilliant blue of this stone is probably the main reason for its popularity, for it is opaque, soft, does not take a high polish, tends to fade in colour, and ought not to be immersed in water. Pure pieces are rare, and very often 'matrix turquoise' is used—that is to say, turquoise mottled by pieces of the stone in which it is found. It is a phosphate of aluminium, containing a little of the oxides of iron and of copper.

Persian turquoise, which is blue, is the best. Egyptian stones are green; while Mexican turquoise ranges from pale blue to green. In the East, turquoise is thought to bring good fortune to its wearer, and it is used often in rings and to ornament daggers, knives, and sheaths.

See also MINERALS; Colour Plate opp. p. 288.

TYPHOON, *see* HURRICANE.

U

UGANDA. Though this British East African country lies across the Equator (*see* Map, p. 5), it is for the most part so high that the climate is not unbearably hot. In its south-east corner is the northern half of Lake Victoria, from which the River Nile flows northwards through the shallow Lake Kyoga, covered with papyrus and water-lilies, and over the Murchison Falls into the Rift Valley. The Rift Valley crosses the north-western corner of the country. On the south-western border there is the great range of Ruwenzori, the Mountains of the Moon, with its snow-covered peaks and glaciers—even on the Equator. On the eastern border the immense old volcanic cone of Mount Elgon rises

NATIVES OF THE KAVIRONDO TRIBE IN UGANDA
Their hedged villages can be seen in the background
Royal Geographical Society

to over 14,000 feet. Most of Uganda consists of flat-topped, grass-covered hills dotted with trees and cut by valleys, in the bottoms of which are papyrus swamps. The lower slopes of the hills are thickly cultivated.

Round Lake Victoria, on the slopes of the Ruwenzori Mountains and Mount Elgon, and in the Rift Valley, the people are gardeners. Each mud and thatch house is surrounded by plantain orchards and gardens, where the women grow sweet potatoes, maize, cassava, and ground-nuts.

North of Lake Kyoga there is less rain, and grain crops, such as maize, millet, and sorghum, are grown. The people of the north have different ways from those of the south: they build their homes in villages, cultivating the land round about. Sometimes they join in order to cultivate big fields of cotton or ground-nuts. They are beginning to use ploughs here and there; but usually the plots are so small that they can only be cultivated with hand-hoes. In the dry south-west, cattle-herding is the main occupation.

See also East Africa.
See also Vol. I: East Africans; Negro Africans.

UKRAINE. The north shores of the Black Sea (q.v.) are the southern boundary of the Soviet Socialist Republic of Ukraine (*see* Map, p. 459). Ukraine means the 'border land', and for many centuries this country was the scene of raids and warfare between the Russians, the Poles, and the Germans. To-day its intensively cultivated farms and big industries support about one-fifth of the population of the U.S.S.R., though the Ukraine itself occupies only about one-fiftieth of the area of the U.S.S.R.

The Ukraine is part of the Great Plain of Russia. In the north, level plains broken by woods and marshes continue north-westward into Byelorussia (q.v.). Here, the rearing of dairy-cattle is the main occupation, grass and potatoes the chief crops. To the south lies the 'steppe', which forms about three-quarters of the Ukraine. The northern steppe used to be covered with woodland, but much of this has been cleared. The River Dnieper divides the northern steppe into almost equal east and west divisions, flowing through orchards, vineyards, and fields of sugar-beet, grain, and potatoes—a land where pigs are bred and dairy-cattle kept. Villages are often very lovely, their thatched

A COLLECTIVE FARM VILLAGE IN THE UKRAINE. *S.C.R.*

cottages being set amid orchards and woodlands. The southern steppe, the real 'steppe' land, is treeless. The flatness of its broad plains of rich black soil (it is often known as the 'Black Earth Land') is broken only by the deep ravines of streams, often dry. The large collective farms of this great grain region are cultivated in huge fields, so that before harvest there appears to be a sea of standing corn. These farms are now highly mechanized. In winter, the country is covered with snow; in spring, the fresh green of the young corn and the masses of wild flowers, mostly bulbs, make the country lovely; but as the heat of summer burns up the land, all becomes brown and dry. In the valley of the Dnieper grapes and peaches are grown, and towards the south, cotton, rice, tobacco, sunflowers, and melons.

In the extreme south, the beautiful Crimean Peninsula juts out into the Black Sea. The Crimea has the mildest climate in the whole U.S.S.R. Rain falls in the winter, and the summer heat is tempered by the sea.

Besides industries arising from the agriculture of the Ukraine, such as flour-milling, distilling of potato alcohol, refining of sugar-beet, leather-work, and cotton-weaving, there are great industries dependent on its mineral wealth. Coal, limestone, and iron-ore are mined, and salt, mercury, bauxite, and manganese are also obtained. Electricity is generated by a power-station on the Dnieper and also by coal-driven stations in the east. Iron and steel goods of many kinds, fertilizers and chemicals are manufactured at Kiev, and river-boats built. The Dnieper and its tributaries carry much local traffic. Heavy goods, such as pig-iron, are carried by barges, while timber is floated down. There is an excellent railway network.

The most important cities of the Ukraine are Kiev (q.v.) and Kharkov. Kiev is the third city of the U.S.S.R., renowned both for its ancient history and its modern industry. Kharkov is only some 350 years old, having become important first as a commercial and later as an industrial centre. It is one of the most important

engineering towns in the U.S.S.R. Until 1934, when Kiev took its place, it was the capital of the Ukraine.

See also U.S.S.R.

ULSTER, *see* IRELAND.

UNITED STATES OF AMERICA. The U.S.A. has a population of 151 millions, and is the fourth largest country in the world, only the U.S.S.R., Canada, and Brazil being bigger. It covers an area of over three million square miles and is bounded on the north by Canada, on the south by Mexico, and on the east and west by the Atlantic and Pacific Oceans. Along the west coast are the great ranges of the ROCKY MOUNTAINS (q.v.), which, with the Cascade and the Sierra Nevada Mountains, stretch in a long but not unbroken chain from Canada to California. The highest peak in the U.S.A is Mount Whitney in California—over 14,500 feet above sea-level—only 86 miles from which is Death Valley, the lowest point in the country, 276 feet below sea-level. In the east the other great line of mountain ranges, the APPALACHIANS (q.v.), stretches from Alabama to the St. Lawrence. Between the Appalachians and the Rocky Mountains are the prairies, great rolling plains with less and less rainfall the farther west they are, until near the Rocky Mountains there is scarcely enough rain to allow grass to grow. Variations in rainfall and climate have an important effect upon the occupations of the people. In the eastern prairies are the great corn (maize) belts; to the west and north-west, where the climate is drier and cooler, are wheatlands; farther west still, where the rainfall is too small to grow crops and where even grass is scanty, are great ranches. Cattle and sheep need to wander over large areas of these in order to get enough to eat. This is the country of vast treeless plains where buffaloes once roamed.

The chief river of the U.S.A. is the MISSISSIPPI (q.v.)—1,700 miles long. It flows across the country from north to south, from Minnesota to the Gulf of Mexico, and is joined by other mighty rivers, such as the Missouri, the Ohio, the Red River, and the Arkansas. Together they form one of the largest inland navigation systems in the world.

THE UNITED STATES OF AMERICA

The United States of America is so big that in many ways it is more a continent than a country. New York (q.v.), the largest city on the east coast, is nearly 3,000 miles from Los Angeles (q.v.), the largest on the west, and the fastest trains take three days and two nights to cover the distance. In variations of climate, too, the country resembles a continent. In the south-west it is like that of Spain; in the north like that of Norway. Maine and Michigan may be buried deep in snow, while Florida and Texas are enjoying tropical heat. A Bostonian would find himself more at home in London than in New Orleans; and to a native of South Dakota, the scenery of the Hudson valley in the north-east would appear strange and foreign. But in any small area there is much less variety of scenery than there is in Britain. This is one reason why Americans dislike walking, for in America one cannot, as in Britain, include in a day's walk hills and lowlands, seaside and woodlands. Very long distances often have to be covered before there is a real change of scenery. There are many long, straight roads, along which the Americans speed in high-powered cars.

VERMONT, NEW ENGLAND
Ewing Galloway, N.Y.

The United States has been said to be the richest country in the world. It has made great use of its rich mineral wealth, and has produced more than three-fifths of the world's supply of petrol, and almost a half of the [illegible] and lead. But as some of the less developed parts of the world, such as eastern Asia and [illegible] America, become more exploited, the relative position of the U.S.A. may be less favourable. The United States is also a great agricultural country, famous for its cotton and tobacco plantations, its wheat-fields and cattle-ranches, [illegible] fruit, and its dairy produce. Skilful organization brings the varied products of the country swiftly to market. There are 121 major railroads, some of them crossing mountains and deserts. Road transport has been developed to a far greater extent than in any other country, and it is estimated that one-third of the world's paved highways, and nearly four-fifths of its motor vehicles are in the U.S.A. Water transport is also very important, and there are steamships on great rivers like the Mississippi, the Missouri, and the Ohio, on the Great Lakes (q.v.), and on canals like the New York State Canal. Air services, not only from the U.S.A. to other countries, but also from one part of the U.S.A. to another, are being more and more used.

The U.S.A. is often divided into regions which have certain features in common—the Industrial North-East; the Middle West; the Old South; a region made up of the Great Plains; the Rocky Mountain States, and the South-West; and, finally, the Pacific coast states. The Industrial North-East includes the New England states north and east of New York, which were settled originally by the Pilgrim Fathers. It is still 'stern and rockbound' country, where farming is very difficult; but there is abundant water-power and many big industries. The chief city is Boston (q.v.) which, despite its mixed population, prides itself on being the most English city in the United States. The region extends south and west through the states of New York, Pennsylvania, New Jersey, Delaware, Maryland, and West Virginia. The most important cities are New York, Philadelphia, and Pittsburgh—celebrated for its great steel-smelting works—as well as Washington (q.v.) the Federal capital.

The Middle West region is oddly named, because the states of Ohio, Indiana, Illinois,

SOUTH CAROLINA: NEGROES PICKING COTTON ON A PLANTATION
Ewing Galloway, N.Y.

Michigan, Wisconsin, Minnesota, Iowa, and Missouri, which make it up, are really neither middle nor west, being all in the eastern part of the United States, and lying south of the Great Lakes and in the upper Mississippi valley. It was completely agricultural until the end of the 19th century. Agriculture is still important; but the growth of the steel industry and of motor manufacturing have made great changes. The chief industrial centres are CHICAGO (q.v.) and Detroit—famous for the Ford motor works.

The Old South or Deep South is predominantly agricultural. The names of many of its states—Kentucky, Alabama, Tennessee, Carolina, Virginia, Louisiana, and Georgia—are known in romance as well as in history. It was from New Orleans, at the mouth of the Mississippi, that jazz first came. Florida, in the extreme south-east, is a favourite holiday place. Most of the negro population of the United States live in the South, many of them working on the plantations and farms, growing cotton, rice, sugar-cane, tobacco, and fruit (*see* AMERICAN NEGROES, Vol. I). But the character of a great part of the Old South has been changed by the remarkable achievement of the Tennessee Valley Authority. The T.V.A. was established in 1933 to develop the resources of the valley of the Tennessee River, and to harness the river so that it should work for prosperity instead of destruction. Huge government-owned dams have been built to control the flooding of the river, and to put a stop to the SOIL EROSION (q.v.), which had been ruining the land. The great mass of water-power is used to provide very cheap electricity both for industrial and for domestic use. Government grants have made it possible for the farmers to put the necessary capital into their land to bring it back into prosperity. This great scheme covers an area of land almost the size of England and Scotland, and affects the lives of some four and a half or more million people. The T.V.A. is being successful in turning the Tennessee valley from a poverty-stricken region into a flourishing agricultural and industrial settlement.

The region of the Great Plains and the Rocky Mountain States stretches southwards from

THE ROCKIES: MOUNT RAINIER NATIONAL PARK, WASHINGTON
Ewing Galloway, N.Y.

Canada through Idaho, Montana, the Dakotas, Wyoming, Nebraska, Colorado, Kansas, Oklahoma, to Texas and New Mexico. It is sparsely peopled and most of the land is fit only for pasture; though in the Dakotas, for instance, there are large areas of wheat. This is the cowboy country, but very different now from the Wild West of fiction. Although the cowboy still lives on a ranch, to-day he is just as likely to ride on the plains in a motor-car as on a bucking broncho. Here, too, live the descendants of the Plains Indians who, until the white man came, lived by hunting the buffalo (*see* AMERICAN INDIANS, Vol. I).

Irrigation is being developed in the West, and striking results are seen from the Roosevelt Dam in Arizona, the BOULDER DAM (q.v. Vol. VIII) on the Colorado River, and vegetation schemes round Salt Lake City in Utah. Texas and Oklahoma have rich oil wells, and minerals bring wealth to the Rocky Mountain states. West of the mountains in the south there is California, still a land of promise to many Americans, except for the south-east, where it merges into the deserts of Arizona and Nevada (*see* COLORADO DESERT). The greater part of the state, including the towns of SAN FRANCISCO and LOS ANGELES (qq.v.), has the most even climate and the greatest variety of scenery in the United States. It is a great fruit-growing area, its huge fruit-farms being called 'ranches'. From San Francisco a magnificent highway runs north for a thousand miles to Seattle. In the states of Oregon and Washington there are orchards and mighty forests with great lumber camps.

See also Vol. I: AMERICANS.

UNIVERSE. The universe (Lat. *vertere, versus*, to turn, and *unus*, one) includes not only all the heavenly bodies which 'turn as one', but also the void in which they turn. In SPACE (q.v.) we learn that this is no longer thought of as unending. The various types of heavenly body are described in separate articles under COMET, EARTH, METEOR, MOON, NEBULAE, PLANETS, STARS, and SUN; their 'apparent' movements, or the movements they appear to have as viewed from the Earth, will be found under ASTRONOMY,

MODERN). Here we shall deal with their arrangement in the heavens.

When we look at the night sky we might think that, apart from the Moon (and by day the Sun), all the other lights we see are very much the same size and, quite possibly, much the same distance away. We should be very wrong. Let us first think of our little Moon, about a quarter the size of the Earth and a mere quarter of a million miles away from us; then of the Sun, round which the Earth and the other planets revolve as the Moon revolves round the Earth. We think of the Sun as enormous, since it is more than a hundred times larger than the Earth in diameter; but some of the stars we see as tiny points of light are really so vast that they could engulf not only the Sun, but more than the whole orbit of the Earth, which is some 186 million miles across. They lie at such unthinkable distances away in space that although the light from the Sun travels 93 million miles to the Earth in eight minutes, their light takes more than three-quarters of a million years to reach us. And these vast stars are small compared with some of the clouds of glowing matter we know as nebulae, certain of which have been photographed through enormously powerful telescopes at distances up to five hundred times farther.

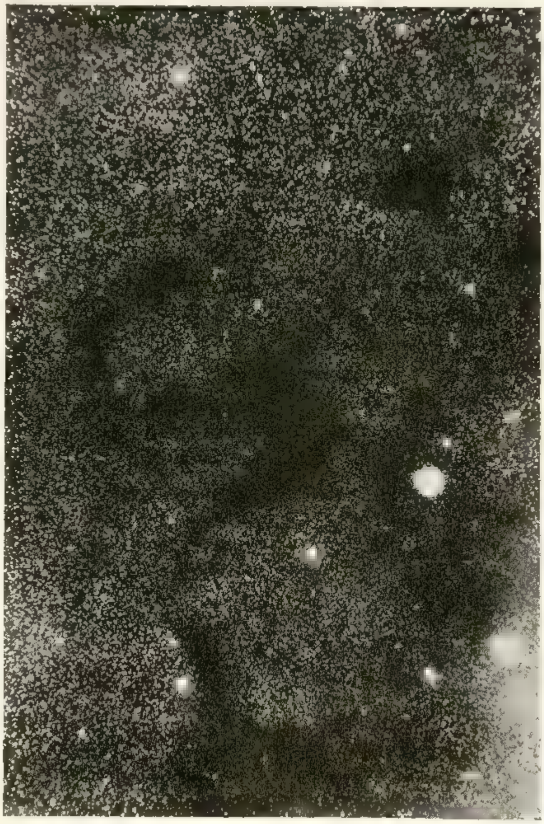
One region of the sky seems particularly full of stars—the great hazy belt of light known as the Milky Way or Galaxy. This stretches from horizon to horizon, passing within about 30° of the Pole Star and through the CONSTELLATIONS (q.v.) Cassiopeia, Perseus, Scorpio, and Sagittarius—where it is densest and brightest. The light given by it is twice as great as that of the rest of the stars in the sky.

It has been suggested that the Milky Way is a flattened disk of stars, or spiral nebula, and the Sun (with its little solar system round it) just one of the hundred thousand million or so stars in it. Such spiral nebulae exist in very distant parts of the heavens. If our Milky Way really is a spiral nebula, it seems that the Sun is not at its centre (which lies more in the direction of Sagittarius) and that the whole system is rotating.

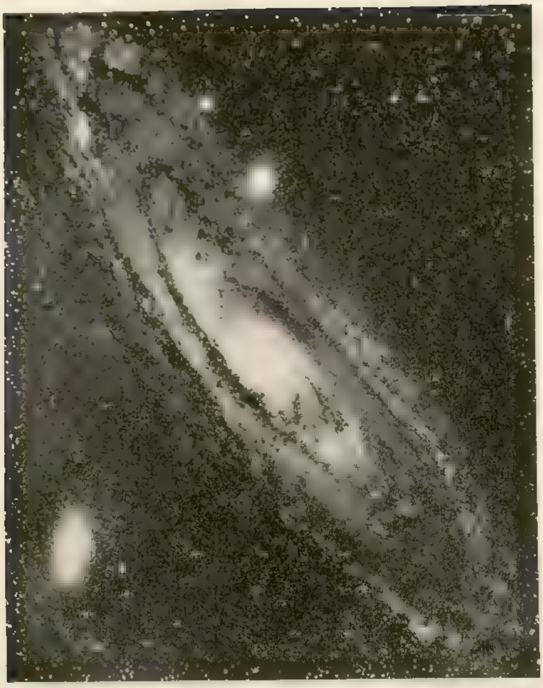
NEBULAE (q.v.) of other types are found in the Galaxy, and many of the spiral nebulae can be seen at right-angles to the plane of the Milky Way. Spectroscopes show that these nebulae seem to be rapidly receding from our system, and this has given rise to the idea that the universe is expanding. Some astronomers, however, doubt this interpretation of the spectroscope readings—and since the mathematics of RELATIVITY (q.v.) suggest that the universe may be either expanding, shrinking, doing both in turn, or doing neither, no definite conclusion can yet be reached.

The Milky Way seems to be larger than most of the nebulae; but measurements are not easy. Between these 'island universes' are immense expanses of space—so immense, indeed, are the intervals between the heavenly bodies in general, that although to our eyes the myriads of stars in the skies seem to be almost touching each other, we ought really to think of them as no more closely packed on an average than forty or fifty oranges would be if they were distributed throughout a space the size of the Earth!

There are strong reasons for thinking that the Universe cannot have existed for ever and that creation took place at some definite time in the



THE MILKY WAY SHOWING DARK CLOUDS
Mt. Wilson Observatory



THE GREAT NEBULA IN ANDROMEDA
Ackland Observatory

past. Various pieces of evidence suggest that this event happened approximately three thousand million years ago (*see* EARTH, HISTORY OF).

See also ASTRONOMY, MODERN; ASTRONOMY, HISTORY OF; ASTRONOMY, MEASUREMENTS OF.

URAL MOUNTAINS. These run from north to south for some 1,500 miles across the U.S.S.R., and form the traditional boundary between Europe and Asia (*see* Map, p. 459).

In the Carboniferous period (*see* EARTH, HISTORY OF), the Earth's crust in Asia was forced against the eastern edge of the stable block of the Great Plain of Russia and crumpled up, making the Ural Mountains. As pressure was from the east, there was greater disturbance on the eastern side of the mountains, which now rise steeply above the plains of Soviet Asia. On the west they rise gradually from the eastern edge of the Great Plain of Russia. In the far north, the Urals consist of one narrow range; but south of the Arctic Circle this broadens into the four or five parallel ranges of the central Urals. Near their southern end the Urals become undulating country of ranges and hills.

Except towards the south, the Urals have little rugged grandeur or wild beauty. Forested ridges fall gently to wide valleys. In the north the coniferous woods give way near the ridge-tops to a low tundra type of vegetation. In the central Urals there are mixed woods with a large proportion of birch. The southern Urals are different in that the ridges are higher and the valleys between are deeper and have steeper sides. It is steppe country, and there is little woodland except on the ridge-tops.

To-day the Urals are of great importance because of their mineral wealth—it is said that practically every mineral occurs in them. Iron-ore is the most important and there are vast deposits of extremely pure ore; but chromium, nickel, bauxite, copper, manganese, wolfram, zinc, lead, silver, and platinum are all found in quantity. Coal is mined in the west and there are several oil-fields. In addition there are rich deposits of potassium salts, of asbestos, and a considerable wealth of precious and semi-precious stones.

Great industries have risen in the Urals, including oil and steel works, copper refineries, general engineering, chemical industries, and paper and cellulose mills. Agriculture has made advances too. Round the big cities there are market-gardens and dairy-farms. In the south the steppe lands grow rye, oats, and wheat. Cattle, sheep, and horses are reared.

There are several towns in the Urals with populations well over 100,000. The largest are Sverdlovsk (about 500,000), Ufa, Izhevsk, and Magnitogorsk. The last lies at the foot of Magnetnaya Mountain, which is composed almost entirely of iron-ore.

See also MOUNTAIN BUILDING; U.S.S.R.

URANIUM. This hard, white metal is the heaviest element existing in a natural state (a few heavier elements have been made artificially). It is radioactive, and by giving off particles and rays, transforms itself in the course of millions of years into a series of different elements, including radium, ending finally as lead (*see* ATOM, Fig. 3). The ore of uranium is 'pitchblende', which consists principally of uranium oxide, but contains also a small amount of radium. Since radium is a product of the decay of uranium, it is always present in the ore. In recent years, uranium has become of immense importance, since it is the only element which, in our present state of knowledge, can conveniently be used for the production of ATOMIC

ENERGY (q.v. Vol. VIII). Uranium deposits are k... in Saxony, Bohemia, the U.S.S.R., the Belgi... Congo, East Africa, Colorado, and Canad... but there can be little doubt that other sour... f supply will shortly be exploited.

Se... MATTER (chart); METAL ORES.

URA...S, *see* PLANETS, Section 9.

URU...AY. This is the smallest country in Sou... erica, and has a population of rather ove... millions. It lies on the Atlantic coast, and ... rounded on three sides by water (*see* Ma... 15). On the east is the ocean, on the sout... great estuary of the Rio de la Plata (Riv... ...te), and on the west the River Uru... the boundary with Argentina. Even the ...ern boundary with Brazil is partly made ... water—in the north-west, by a tributary ... Uruguay, the River Quarahim, and in th... ...th-east by the long Lake Mirim. The River Uruguay is navigable as far as Salto, some 200 ... above the estuary, and has many good river ...s. Its shallow waters and well-wooded shore... ke a paradise for smugglers, and in spite ... nany customs posts on both sides, a good ... l of smuggling goes on between Urug... and Argentina. The river has many tribu... flowing eastwards, the largest of which is the Negro. This river and its tributaries form a complex irrigation scheme watering a large part of the country, and they also provide a system of waterways used by motor-launches.

Uruguay is a country of rich, rolling grassy plain, broken in the north by low rocky ridges which stretch up into Brazil. The plains are well watered, their rich fertile soil supporting both woodland and meadow. In the spring, they are brilliant with purple wild flowers—and these, with the purple mists that gather in the distance, have given Uruguay the name of the Purple Land. On these rich grasslands are the ranches, which with their great herds of cattle, horses, and sheep, form the principal wealth of the country. Enormous meat-packing houses chill or freeze the beef and mutton for export to Europe. Large quantities of meat extract, in liquid or jelly form, are also produced. In the south-west a Swiss colony produces fine butter, cream, and cheese. Uruguay has a mild and pleasant climate, which varies little between winter and summer. The winters are so mild that no shelters are needed for the cattle, and they roam at large over the gently rolling plains, well-watered and well-fed.

MONTEVIDEO (q.v.) is the capital. Salto and Paysandu, both on the River Uruguay, are the next most important cities, and the country has

CATTLE ON THE RICH, WELL-WOODED PLAINS OF URUGUAY. *Dorien Leigh*

some of South America's finest summer resorts, with a chain of excellent bathing beaches along the coast of the Rio de la Plata.

See also SOUTH AMERICA.
See also Vol. I: URUGUAYANS.

U.S.S.R. The Union of Soviet Socialist Republics occupies about one-seventh of the land area of the world, three-quarters of it being in Asia. It stretches westwards from the Bering Sea (where it is only 36 miles distant from Alaska) to the Baltic Sea, and south from the Arctic Ocean to the BLACK SEA, the CASPIAN SEA, and the mountains and deserts of the heart of ASIA (qq.v.).

There are sixteen Soviet Socialist Republics in the Union. Of these the R.S.F.S.R. (the Russian Soviet Federative Socialist Republic) (q.v.), occupying about three-quarters of the U.S.S.R., is by far the largest. The other fifteen Soviet Socialist Republics are FINNO-KARELIA, ESTONIA, LATVIA, LITHUANIA, BYELORUSSIA, MOLDAVIA, UKRAINE, GEORGIA, AZERBAIJAN, ARMENIA, KAZAKHSKAYA, UZBEKISKAYA, TADJIKSKAYA, KIRGISKAYA, and TURKMENSKAYA (qq.v.). These Republics each return 25 deputies to the Soviet of Nationalities which, together with the Soviet of the Union, forms the Supreme Soviet. The Soviet of the Union is elected by all citizens over 18 years of age, on the basis of one member to each constituency of 300,000 people (*see* RUSSIAN CONSTITUTION, Vol. X). The total population of the U.S.S.R. is 193 millions.

The Great Plain of Russia stretches across European Russia and across the northern part of Asiatic Russia as far as the Yenisei River. To the south-west are the CAUCASUS MOUNTAINS (q.v.) of Georgia, Azerbaijan, and Armenia, which run from the Black Sea to the Caspian Sea. To the south-east are the great mountain chains which curve from the Pamir Mountains through Tadjikskaya and Kirgiskaya. East of the Yenisei, and extending northward beyond the Arctic Circle, are the high plateaux, deserts, and mountain ranges of north-east Asia. The URAL MOUNTAINS (q.v.), crossing the Great Plain from north to south, form the traditional boundary between Europe and Asia.

Climate everywhere in the U.S.S.R. is continental (*see* CLIMATE, Section 3). As the Arctic Ocean is neared, winters get longer and colder, and summers shorter and cooler. Eastward the climate gets more and more extreme. In the south-west there are short mild, wet winters and hot dry summers. The absence of high mountains and plateaux in the Great Plain of Russia results in a gentle gradation of climate northward and southward, and in an absence of sudden changes of way of life.

The U.S.S.R. is a land of great rivers. In the western U.S.S.R. the Great Plain is crossed by the Dvina, the Dnieper, the Don, and the VOLGA (q.v.), and these are linked by canals to make a waterway from the Black Sea to the Baltic. In eastern U.S.S.R. the Yenisei and the Amur (in the extreme east) are navigable for over 2,000 miles from their mouths, and the Lena is navigable for smaller craft.

The full resources of the U.S.S.R. are still unknown; but it is known that within her wide frontiers almost any raw material can be obtained either by cultivation or from her rich mineral deposits. Coal is found in abundance in several areas; there are three main oil regions round Baku on the Caspian, the Pechora River in the north of the R.S.F.S.R., and the island of Sakhalin in the extreme east; iron and many other minerals and precious stones are present in quantity. Wool, cotton, and flax are grown, most of the cotton coming from Uzbekiskaya where the plantations are irrigated, and Azerbaijan. Great quantities of grain come from the rich steppe lands on the Great Plain. A vast amount of timber comes from the taiga regions, the stretches of coniferous forests in the north. New roads and railways, towns and industries have sprung up, and agriculture has been revolutionized by mechanization and the cultivated areas greatly extended. The U.S.S.R. is no longer a backward, impoverished country of illiterate peasants, but a world power with a great potential future.

See also R.S.F.S.R.; ASIA.
See also Vol. I: RUSSIANS; SIBERIAN PEOPLES; SOVIET CENTRAL ASIAN PEOPLES.

UTAH, U.S.A., *see* UNITED STATES OF AMERICA.

UZBEKISKAYA (UZBEKISTAN). The Soviet Socialist Republic of Uzbekiskaya has Tashkent as its capital and Samarkand and Bokhara (Bukhara) within its borders.

Uzbekiskaya lies between Turkmenskaya and Tadjikskaya, with Kazakhskaya to the north and Afghanistan to the south (*see* Map opposite).


Land over 12,000 ft.
" " 3,000 ft.
" " 1,500 ft.
Miles
250 0 250 500 750
NORTH
ARCTIC OCEAN
BARENTS SEA
Nova Zemlya
BERING SEA
FINLAND
FINNO-KARELIA
Kola Pen.
White Sea
Murmansk
Archangel
N. Dvina
L. Onega
Leningrad
Novgorod
G. of Finland
Tallin
ESTONIA
Riga
LATVIA
LITHUANIA
Konigsberg
POLAND
Minsk
Moscow
Gorki
Kazan
Kuznetsk
Kursk
Kharkov
Kiev
Dnieper
UKRAINE
ROUMANIA
MOLDAVIA
Odessa
Crimea
Kerch Pen
BLACK SEA
TURKEY
Stalingrad
Volga
Saratov
Astrakhan
CASPIAN SEA
Baku
Tiflis
TRANSCAUCASIA
AZERBAIJAN
RUSSIAN SOVIET FEDERATIVE SOCIALIST REPUBLIC
Pechora
Urals
Ob
Yenisey
Sverdlovsk
Magnitogorsk
Omsk
KAZAKHSKAYA
Emba
Aral Sea
Kara Kum Desert
Amu Darya
L. Balkhash
KHAKASS
Altai Mts.
Tashkent
Frunze
Alma Ata
KIRGISKAYA
UZBEKISKAYA
Samarkand
Bokhara
Stalinabad
TURKMENSKAYA
Ashkhabad
PERSIA
AFGHANISTAN
Hindu Kush
PAKISTAN
TIBET
SINKIANG
CHINA
Tungu Mts.
Lena
YAKUTSK A.S.S.R.
Irkutsk
Lake Baikal
Shilka
Argun
Amur
Urga
OUTER MONGOLIA
Gobi Desert
INNER MONGOLIA
Khingan Mts.
MANCHUKUO
Hsingking
Mukden
Vladivostok
Blagoveshchensk
SEA OF OKHOTSK
SAKHALIN
Kamchatka
SEA OF JAPAN
YELLOW SEA
60
80
100
120

THE U.S.S.R.

THE STALINABAD–TASHKENT HIGHWAY, UZBEKISKAYA. *S.C.R.*

North-west Uzbekiskaya is part of the deserts round the south of the Aral Sea. The Amu Dar'ya River, the Oxus of legend, separates the sand-desert of Kara Kum in the west from the stony clay desert of Kizil Kum. On the latter, stretches of poor steppe grassland provide pasture for sheep, including the Karakul breed which yield skins of Astrakhan and Persian lamb. The Amu Dar'ya is a fast-flowing, large river, bordered by an irrigated belt in which wheat, cotton, and fruits are grown. South-east of the deserts, Uzbekiskaya rises to the foot-hills of the Tien Shan Highlands and the Pamir Mountains (*see* Asia).

The largest cultivated area in Uzbekiskaya, and the most fertile, is the irrigated Fergana valley in the east. Cotton is grown, as well as sugar-beet, vines, fruit of many kinds, and even rice. Sheep, horses, and cattle are reared. Uzbekiskaya has coal-mines and, in the south, oil wells.

The three main towns are all ancient cities. Tashkent, the largest city and the capital, is the centre of trade for a large part of Soviet Asia. To the old city, with its low flat-roofed houses, its colourful bazaars, mosques, and tall minarets, there has been added a new city of factories, flats, hospitals, and schools, with broad roads, electricity, and buses. Samarkand, the capital of Asia in the time of the great Tamerlane, was the Golden City captured in turn by Alexander the Great and Genghis Khan (qq.v. Vol. V) and by the invading armies that swept in restless waves backwards and forwards across the eastern boundary of Europe. Within the walls of the old city there are richly adorned mosques and schools, and the tomb of Tamerlane. Round the walls are gardens, vineyards, and orchards. Modern Samarkand has factories, mills, power stations, schools, and broad streets. Bokhara is still an eastern city almost untouched, for the new town with its cotton-mills and modern buildings has been built on the railway nearly 10 miles away. Old Bokhara is surrounded by mud-brick walls over 15 miles in length, pierced by eleven gates. Within the walls are 365 mosques, a reminder of the religious fanaticism of the city, and rows of low, flat-roofed houses, each built round a courtyard, so that from the narrow streets no sign of life is apparent. In the great vaulted market-place or bazaar are still displayed the rugs which are known throughout the world, as well as silks and jewellery made by native craftsmen.

See also U.S.S.R.
See also Vol. I: Soviet Central Asian Peoples.

V

VALENCY, *see* CHEMISTRY.

VALLEYS. A valley may be a narrow depression on a hill-side down which a stream tumbles, or it may be a wide, broad, flat plain bordered by gently rising slopes; it may be a deep cleft in rocks with water foaming at the bottom, or it may be a fertile trough bounded by cliffed walls; it may be U-shaped in cross-section, or it may be V-shaped. It may not even be called a valley, but instead, because of its shape, a ravine, a canyon, or a gorge; or because of its locality, a glen, a dale, or a strath. There are valleys, called dry valleys or wind gaps, which no longer have streams in them; and there are valleys which end off by opening suddenly into another valley, high up in its side: these are called hanging valleys (*see* GLACIATION).

Most valleys owe their origin to a river. Normally a river in its upper course cuts rapidly down into the ground, so that a V-shaped hollow with steep sides results; but gradually wind and rain wear away the sides into more gentle slopes. The river itself widens the valley floor; for wherever the nature of the ground has made a slight curve in its course, the river tends to enlarge that curve by undercutting the bank against which the current strikes. In its middle course the river cuts down into the ground less rapidly, so that the wearing away of the valley sides keeps pace better with the deepening of the valley floor, and a much wider and shallower V results. Eventually the sides of the valley may become so flat and the valley floor so wide that the V-shape is not immediately noticeable, and the lower river valley looks like a plain (*see* DENUDATION).

In areas of very hard rock, streams tend to follow lines of weakness, such as 'joints' (or cracks), and gradually cut a gorge through the rock. The hard sides of the valley do not then weather away into slopes, but become cliffs. Gorges are formed in other ways too: one of the most famous gorges or canyons, the COLORADO CANYON (q.v.), is to a large extent the result of so small a rainfall that the down-cutting action of the river has far outstripped the weathering away of the valley sides. In most limestone areas, the rivers flow underground in channels: where the roofs of these channels have collapsed, a gorge results, as, for example, in the Cheddar Gorge (*see* CAVES).

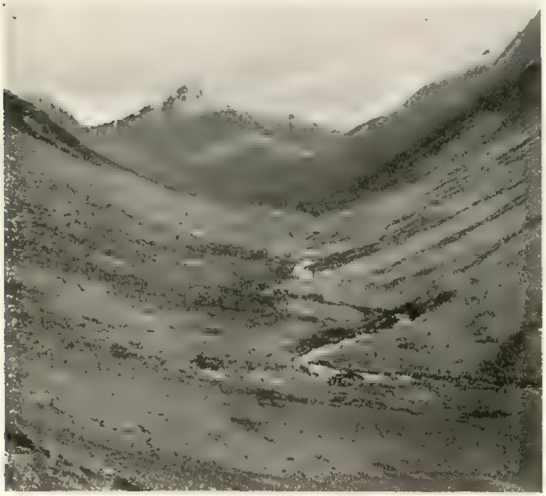
U-shaped valleys result from ice action. During the ICE-AGE (q.v.) large areas of the world were under the action of ice, and even to-day there are many mountain areas perpetually covered by snow and ice. U-shaped valleys are the channels of former GLACIERS (q.v.) or rivers of ice, and their bare, smoothly-worn sides are witness to the immense power of the ice. The glens of Scotland, the dales of the Lake District, and the valleys of the Welsh Mountains are glaciated valleys.

As route-ways, valleys have been, and still are, of great importance in mountainous country. In slightly hilly country they were often

CHEDDAR GORGE WITH ITS CLIFFS OF CARBONIFEROUS LIMESTONE. *Crown Copyright Reserved*

avoided, for their marshy and wooded floors were less easy to travel along than the drier, more open hill ridges. In very hilly and mountainous country, however, the valleys are the only route-ways, and it is the mountains with no well-developed valleys that form the greatest barriers, e.g. the PYRENEES between France and Spain, the Pindus Mountains of the Balkans, the CAUCASUS of the U.S.S.R., and the ANDES (qq.v.) of South America.

In hilly and mountainous country, too, valleys are important as being the only places where man can settle. Their more sheltered climates, and the presence of water and of soil to cultivate, resulted in valley settlements from very early times. Since communication with neighbouring valley settlements was often difficult, each community tended to develop its own way of life and social consciousness. It was in river valleys that most of the early civilizations of the world grew up—as, for instance, the EGYPTIAN CIVILIZATION in the Nile valley, the



A U-SHAPED VALLEY IN THE ISLE OF ARRAN, SCOTLAND
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civilizations of the SUMERIANS, BABYLONIANS, and ASSYRIANS in the Euphrates and Tigris valleys, the ancient INDIAN CIVILIZATION in the Ganges valley, and the ancient CHINESE CIVILIZATION in the valley of the Yellow River (qq.v. Vol. I).

VALPARAISO, *see* CHILE.

VELD, *see* GRASSLANDS, Section 3.

VENEZUELA. This is the most northerly republic of South America, and borders the Caribbean Sea (*see* Map, p. 415). It is a country of extremely varied scenery, ranging from snowy mountains to tropical grassland or steamy tropical forest and swamp, much of which is practically unexplored.

In the west, the northern tip of the Andes Mountains forks into two branches, separated by the big, shallow lake of Maracaibo. The western branch strikes northwards, marking the western boundary between Venezuela and Colombia. The eastern branch, the Sierra Nevada de Merida, runs north-eastwards to the coast and turns eastwards along the coast, as the Maritime Andes. The Sierra Nevada de Merida is a series of parallel ranges of snow-clad mountains rising to over 15,000 feet. The valleys between the ranges are themselves high above sea-level. The Maritime Andes are two parallel mountain ranges separated by a fertile valley in which live a large proportion of the people of Venezuela. In this valley is Caracas, the capital.

The low, rather marshy, cotton-growing country round Lake Maracaibo in the north-west has become very important since about 1920, when rich oil deposits were discovered and exploited. Venezuela is now one of the main oil-producing countries of the world. Some of the wells have been drilled in the shallow lake-bed itself, and the derricks rise high out of the water. The town of Maracaibo, on the west shore, is the second largest town in the country.

South of the Maritime Andes lie the lowlands of the Orinoco River and its many tributaries. This mighty river is navigable for over 1,200 miles from the sea. It varies greatly in volume and in depth, and in the rainy season it floods thousands of miles of the tangled jungle and swampy forest which border it, especially in the lower reaches. This wet forest land is the home of a great variety of tropical plants and animals. In the western and higher part of the Orinoco lowlands are low, flat, grassy plateaux, called 'llanos' on which herds of horses and cattle are pastured. South of the lowlands are the Guiana Highlands, in parts thickly wooded, in other parts open grassland suitable for cattle-rearing.

Venezuela, as well as oil and cotton, produces and exports rubber from the forests, sugar-cane, coffee, hides, meat, cocoa, precious stones, and minerals such as copper, iron, and gold.

CAS, THE CAPITAL OF VENEZUELA, IN A VALLEY IN THE ANDES. *Paul Popper*

racas, the capital, was founded by the Sp iards in 1567. It was the birthplace of the So h American hero Simon BOLIVAR (q.v. V . V), who liberated Venezuela in 1819. His sta e stands in the main square. The principal po of Venezuela, La Guaira, lies about 24 mi s from Caracas, and is connected with it by an lectric railway.

also SOUTH AMERICA.
See also Vol. I: VENEZUELANS.

VENICE. This most romantic of all Italy's beautiful towns is built entirely on islands in a protected lagoon at the north of the Adriatic Sea. It has canals instead of streets, and instead of the wheeled traffic of an ordinary town, it has motor-boats and steamers, as well as the graceful gondola, which has been the traditional means of transport in Venice for centuries. The sweeping Grand Canal, perhaps the most beautiful 'main street' in the world, is lined with magnificent palaces and crossed by the famous Rialto bridge.

Venice was founded in the 5th century by refugees who fled to this group of islands to find safety from the devastating attacks of Attila and the marauding HUNS (q.v. Vol. I) on the mainland towns of north Italy. The town grew quickly and became rich as a trading centre. At the close of the 7th century, a supreme magistrate, called the 'Doge', was appointed. The Republic of Venice was ruled by him and by councillors elected from among the aristocracy. About A.D. 827, three Venetians succeeded in stealing the body of Saint Mark from its tomb in Alexandria and bringing it with great ceremony to Venice. St. Mark became the patron saint of Venice, and her magnificent 11th-century Cathedral is dedicated to him.

During the Middle Ages, Venice flourished greatly as her trade expanded. The 15th century was her golden age. She not only controlled the main trade-route between East and West, but she built up a considerable empire on the mainland of Italy, down the Adriatic coast of Yugoslavia, and at one time including parts of Greece and even Constantinople. During this time she came into fierce conflict with the other great sea-trading power, GENOA (q.v.). When new routes to the East were discovered in the 16th century, Mediterranean trade and, consequently, the power and wealth of Venice began to decline. The history of this brilliant republic came to an end in 1797, when Napoleon compelled the last Venetian Doge to abdicate, and Venice was handed over to Austria. In 1866, when the various states of Italy united, Venice joined the new Kingdom of Italy.

Venice is now one of the most popular beauty spots of the world. The centre of the city is the Piazza di San Marco, one of the finest squares in Europe. On one side is ST. MARK'S CATHEDRAL (q.v. Vol. XII) with its great Byzantine dome and elaborate decoration. Over its main entrance stand the four magnificent bronze horses which were brought to Venice from Constantinople in 1204. Adjoining the Cathedral is the new Campanile or bell-tower, a copy of the medieval tower which fell in 1902, and a landmark for miles around. Facing on to the square are 15th- and 16th-century offices and residences of magistrates, the beautiful Old Library, and the famous Doge's Palace, a mixture of Gothic and Renaissance architecture. A narrow canal runs between the palace and the municipal prison, and these are connected by a narrow-arched stone bridge called the Bridge of Sighs—the sighs, presumably, of the prisoners passing to the prison. The Grand Canal is bordered by many beautiful and splendid palaces, dating

from the 13th to the 16th centuries. The city is intersected by paths and narrow streets, and the canals are crossed by little stone bridges, so that foot-passengers can go right through the city without entering a gondola. Venice is now joined to the mainland by road and railway viaducts.

See also ITALY.
See also Vol. XII: VENETIAN PAINTING.

VENUS, *see* PLANETS, Section 3.

VESUVIUS. This famous volcano lies south-west of NAPLES (q.v.), rising from the shores of Naples Bay in gentle slopes, and reaching a maximum height of 3,900 feet. From the south, Vesuvius looks like a perfect cone, but from the north and east it shows two peaks separated by a valley. The higher peak is the central cone of the volcano; the lower, called Monte Somma, is the remains of the outer rim of the original crater. This crater rim now protects the northern slopes from the lava flows which have devastated the other slopes. The depression between the two peaks is called the Valle dell' Inferno. Jets of steam rise continually from the main crater and there are often small lava eruptions. Violent eruptions occur only at long intervals, and then ash, hot stones, and even, occasionally, hot mud are ejected.

The great catastrophic eruption of A.D. 79, when the top of the mountain was blown off and the cities of Pompeii and Herculaneum were buried, followed so long a quiescent period that Vesuvius was thought to be quite extinct. Thunder, lightning, and earthquakes accompanied the eruption and added immeasurably to the panic of the multitudes who lived near the mountain. So swiftly was Pompeii buried in the white-hot ash that the inhabitants were caught in the midst of their ordinary occupations —soldiers on guard at their posts, families at meals, and people hurrying home from market. The sky was dark for three days afterwards.

There have been one or two other great eruptions of Vesuvius through the centuries, generally separated from each other by several hundred years. In 1631, after a hundred years of exceptional quiescence, there was a very serious eruption. Again in 1906 the volcano poured devastation over the surrounding country. But nothing has ever equalled the eruption of A.D. 79.

To-day the lower slopes of Vesuvius are still very densely peopled, and small white villages appear among the vineyards, olive groves, and

VESUVIUS DURING A RECENT ERUPTION.
Keystone

From the original in the Wallace Collection, by permission

THE DOGE'S PALACE AND GRAND CANAL, VENICE
Water-colour by R. P. Bonington (1802–28)

THE VICTORIA FALLS
A rainbow in the spray can be seen curving up from the foreground. *South African Railways*

fields of grain and tomatoes which flourish on ch lava soil. Higher up are chestnut groves, and even higher forests of pine, alder, holm oak, beech. In certain areas where there have recent lava flows, only the prickly pear will grow. The upper slopes of the volcano are barren and are covered with snow in winter.

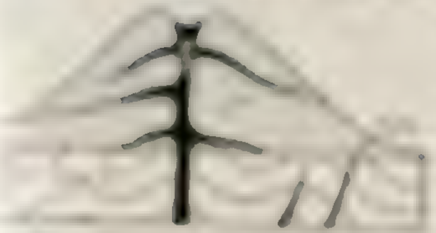
See also VOLCANOES.

VICTORIA FALLS. These famous falls of the Zambesi River, in that part of Africa where the river makes the frontier between Northern and Southern Rhodesia (*see* Map, p. 5) were first discovered about 1856 by the great African explorer David LIVINGSTONE (q.v. Vol. V). Their African name is *Mosioa-tunya* ('smoke thunders there'). The falls were caused by a great crack, stretching across the river, in the hard basalt rock which forms the bed of the Zambesi. A very great volume of water, over a mile wide, cascades over the cliff—a sheer drop of 340 feet, more than twice the drop of the NIAGARA FALLS (q.v.). The fall of the water makes a deafening roar, and throws up vast columns of spray, which can be seen as far away as 20 miles. In fact, in the rainy season, when the river is full, the spray is so great that it practically blots out the falls from sight. The cataract is bounded on three sides by ridges of basalt rock, 300 to 400 feet high, and covered with forest—as are also the many islands in the wide river. The only outlet for the water at the bottom of the falls is a very narrow channel, only about 100 feet wide, through which the river rushes to emerge into an enormous zigzag trough by which it continues its course.

See also RHODESIA.

VICTORIA STATE, *see* AUSTRALIA.

VIENNA. The capital city of AUSTRIA (q.v.), with a population of nearly two millions, remains one of the loveliest cities in Europe, in spite of very severe war damage. It is also one of the most beautifully situated. It lies on a river terrace on the west bank of the DANUBE



[illegible]

ago, are to be found underl[illegible] square miles of the Deccan in India, 300,000 square miles of southern Brazil and Paraguay, and 200,000 square miles of the Snake River and Columbia River plains of North America. These probably were connected with the great movements of MOUNTAIN BUILDING (q.v.) which have occurred in the course of geological history.

The formation of volcanoes may be related to mountain-building movements, for, whether active or extinct, they are mainly to be found in [illegible] where there have been great rock movements.

Extinct volcanoes, like active ones, are usually found in groups and lines; and it is from the study of them in varying stages, as they are being worn away, that the general story of volcanoes has been partially unravelled. It seems that neighbouring volcanoes are fed from a common underground reservoir of molten rock formed by the mixing of basalt with crustal rock. From this reservoir, when enough steam has accumulated to provide explosive power, volcanoes spurt off through the top layers of the crustal rock. Scores of millions of years later, when the rock above has been worn away, these reservoirs are exposed. The [illegible] of Devon and Cornwall [illegible] reservoir which supplied [illegible] times.

See also EARTH; LAVA; [illegible] BUILDING; ROCK FORMATION; [illegible] EARTHQUAKES.

VOLGA. The Volga is the [illegible] Europe, 2,300 miles in [illegible] the Valdai Hills north of Moscow, [illegible] the CASPIAN SEA (q.v.). The R[illegible] 'Mother of all Rivers', both be[illegible] and because it teems with fish, [illegible] food for many people. But [illegible] the greatest importance of the Volga has been its value as a trade-route. This is [illegible] to-day, because canals have been built connecting it with the Baltic Sea and the White Sea in the north, and with the Black Sea and Caspian in the south. Oil from the Caucasus, timber, grain, and salt from the plains of Russia, manufactured goods from the Moscow [illegible] region, and Volga caviare—these are only a few of the cargoes carried on the thousands of boats which ply up and down-stream (see R.S.F.S.R.).

The Volga leaves the southern end of a lake

[illegible]

about [illegible]00 feet high on the Valdai Hills, and flows [illegible] more than 700 miles east to Kazan, on the [illegible] latitude as Moscow. The Volga Canal, open[illegible] 1937, connects Moscow to the Volga, whi[illegible] turn is linked to the Baltic-White Sea Can[illegible] way of its northern tributary, the Shek[illegible] and Lake Onega. Thus Moscow is a great [illegible] port of the system of waterways.

At [illegible]ki the River Oka, which also rises in the Valdai Hills, joins the Volga. At Kazan the Volga turns southward and follows closely the eastern edge of the hills which rise up between it and the Don. For several hundreds of miles the west bank rises to 1,000 feet above the river, while the east bank is low and marshy. The river-bed itself is deeply incised.

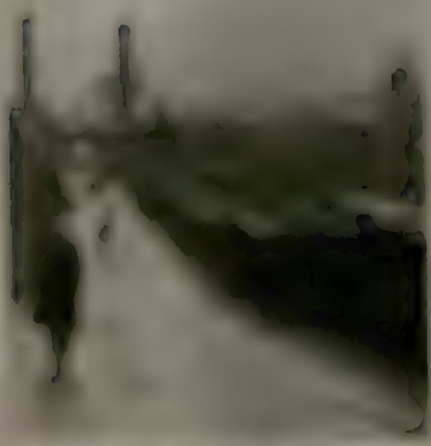
South of Kazan the Volga is joined by the River Kama, which flows west from the Ural Mountains. The combined rivers flow southwest for a short distance, bend sharply east and then west at Samara, a river port and rail junction, and continue in a south-westerly direction to Stalingrad. From Saratov the Volga flows below sea-level for its last 700 miles, owing to the fact that the Caspian Sea is 85 feet below the level of the Mediterranean.

At Stalingrad the Volga is connected to the River Don by a canal which has been recently completed. An eastward bend of the Don, and a westward bend of the Volga, bring the two rivers here to within 40 miles of each other. This new canal is the final link in the system of inland waterways (see RUSSIAN CANALS, Vol. IV).

From Stalingrad the Volga bends sharply, and flows south-west to the Caspian Sea, which it enters by means of a great marshy delta. Astrakhan lies on one of the branches of the delta, 56 miles from the sea. Here oil from Baku, grain, and fish are loaded on river-boats to be carried upstream.

The Volga is rich in fish, especially tunny and sturgeon, from which caviare is produced. The largest fisheries are at Astrakhan, from which port the bulk of Russian caviare is sent to Europe and the rest of the world.

See also RIVERS; U.S.S.R.



AN AERIAL VIEW OF WASHINGTON, D.C.
Ewing Galloway, N.Y.

importance depends almost exclusively on its being the seat of the Federal Government. In it are the Capitol, where Congress meets, the White House, where the President lives, the Supreme Court Building, many government offices, and many memorials to national heroes such as the Lincoln Memorial and the Washington Monument, a towering marble shaft of great beauty, which was for many years the tallest masonry structure in the world. Other buildings which add to the dignity and the significance of the national capital are the CONGRESS LIBRARY (q.v. Vol. IV), one of the world's great libraries, the National Gallery of Art, and, across the river, the Arlington National Cemetery in which is the tomb of the unknown American soldier of the First World War.

The site of Washington was chosen by George WASHINGTON (q.v. Vol. V), after whom it is named, on ground ceded by the states of Maryland and Virginia. The first architect was a Frenchman named L'Enfant, who had been an officer in the American army during the War of Independence. He designed a city as large as the Paris of that day, with stately pu[illegible] [illegible]ildings connected by broad avenues, a[illegible] with canals and fountains such as he had [illegible]en at Versailles. But lack of money and qua[illegible] prevented the full realization of L'Enfant's [illegible]nes, and during the 19th century the city [illegible] in a somewhat haphazard manner, like mo[illegible] [illegible]merican cities. The lessons in town-planning [illegible]ught in the Chicago World Fair of 1893 led to a return to the original plan, and Washington became one of the most beautiful and best planned of the world's capitals, as well as one of the most important. It has a population of about 802,000, of whom about one-fifth are negroes.

See also UNITED STATES OF AMERICA.
See also Vol. X: AMERICAN GOVERNMENT.

WATERFALLS, *see* RIVERS; KAIETEUR FALLS; NIAGARA FALLS; VICTORIA FALLS.

WATERSPOUT. This is a rotating column of water sucked up from the sea or from lakes by a whirlwind. It is usually preceded by a funnel-shaped cloud which comes down from the sky

and eventually links up with the water. The whole thing may then travel slowly across the sea or lake for a considerable distance before collapsing. The causes of a waterspout are much the same as those of a TORNADO (q.v.). Indeed, tornadoes have been known to become waterspouts on crossing water, and waterspouts to become tornadoes on passing over land.

Waterspouts were dreaded with good reason by the seamen who manned small wooden ships, for they could carry men overboard, tear away masts and sails, sweep away boat-decks and fittings, and even capsize ships. In Tunis harbour in 1885 five ships were sunk. Even modern liners may suffer damage from the furious winds and sucked-up water of a large waterspout. The White Star liner, *Pittsburgh*, which was struck in mid-Atlantic in 1923, had her bridge wrecked and some of her cabins damaged, and was deluged by tons of water. She had to stop for an hour while repairs were done.

In olden days there were various strange recipes for scaring away or propitiating 'the monster', as a waterspout was believed to be. One suggestion was to sprinkle vinegar, another was to make a loud noise. Even to-day many sailors believe that the discharge of a gun can break up a waterspout.

Waterspouts are responsible for one of the most remarkable of natural phenomena, the so-called 'rains of fishes'. For hundreds of years rains from heaven of fishes, frogs, toads, and other small animals have been reported, but until comparatively recently scientists were sceptical. However, it is now firmly established that waterspouts can lift shoals of small creatures up in the air, carry them for miles, and then shower them down.

WATER-VAPOUR. This is the invisible gas formed when water evaporates, and is a most important part of the ATMOSPHERE (q.v.). As it has its origins wholly on the earth's surface—in seas, lakes, rivers, ponds, snow and ice-fields, vegetation, and even in the earth itself—it is usually more plentiful in the lower layers of the atmosphere; but apart from this one broad rule it is extremely variable in amount, unlike the other gases in the air, which are always found in about the same proportions at any one height. The atmosphere always contains some water-vapour, even over the driest desert; but, at the other extreme, there is a limit to the amount which it can hold. Until this limit, called 'dew-point', is reached (when the air is said to be 'saturated'), evaporation continues; if it is exceeded, the surplus moisture is liable to be precipitated in some such form as cloud, mist, snow, rain, or dew. In order to assume any of its visible forms, however, water-vapour needs the help of dust on which to condense. Dust is almost always present in the atmosphere; if it were not, the air might become 'super-saturated' with four or five times the normal amount of moisture before precipitation could take place. The dew-point of air varies according to the temperature, as the Table shows, warm air being able to carry much more water-vapour than cold.

Amount of Water-vapour in a Cubic Metre of Air at Dew-point (or Saturation)

Temperature of air		Weight of Water-vapour	
° Centigrade	° Fahrenheit	Grammes	Increase
0	32	4·8	..
5	41	6·8	2·0
10	50	9·3	2·5
15	59	12·7	3·2
20	68	17·1	4·4
25	77	22·8	5·7
30	86	30·0	8·2

The amount of water-vapour in the atmosphere is known as the 'humidity', and it may be stated in several ways: as the weight per given volume of air (as in the Table above); as its pressure in lbs. or other units; or as a percentage of the amount which air at that temperature would contain if it were at dew-point. The humidity of the air is measured by comparing the temperatures on two thermometers, one of which has its bulb covered by a piece of muslin kept constantly wet. The thermometer without the muslin will measure the temperature of the air; but that covered by the wet muslin will be influenced also by the effect of the evaporation of the water, which causes it to lose heat. If the humidity is high (that is, the surrounding air is too moist to take in much more moisture), the evaporation will be low, and the mercury in the thermometer will fall only a little. If the humidity is low (the air dry), evaporation will be high, and the mercury will fall much more. The difference between the readings of the two thermometers

shows the degree of humidity in the air. The old-fashioned 'weather-house', in which a little man with an umbrella and a woman with a sunshade alternately come out of their doorways, shows a cruder method of judging the amount of water-vapour in the air. The bar on which the two figures are mounted is hung on a piece of catgut, which tends to untwist as the humidity increases or to tighten as the air dries, so causing one or other figure to come out. This employs quite a different means of WEATHER FORECASTING (q.v.) from that of the barometer, which measures the PRESSURE (q.v.) of the atmosphere, and not its humidity.

It rarely happens that air reaches dew-point simply by way of evaporation: more usually a mass of partially saturated air becomes cooled to a point at which it can no longer hold the moisture it contains—and so we get clouds or, if the cooling continues further, rain, hail, or snow. But in addition to its obvious connexion with local weather conditions, the presence of water-vapour in the atmosphere has the greatest influence on CLIMATE (q.v.) and even on the suitability of the whole earth for living things. In the article on HEAT, Section 4, we read how the radiant heat of the sun, which can pass freely through dry air, is partly intercepted by water-vapour and forced to give up some of its heat. The clouds, too, reflect back from their shining upper surfaces some of the sun's fiercest rays, and in the same way from their undersides throw back some of the gentler heat radiated from the earth. Moreover, water and water-vapour have the capacity to absorb and store much greater quantities of heat than almost any other substance (*see* HEAT, Section 2), giving it back slowly when the surrounding temperature falls below their own. It is easily seen, then, how the blanket of water-vapour round the earth, whether in the form of clouds or of invisible gas, does in fact act very much as a blanket by preserving the earth's own heat, and also as a shield against the full power of the sun, which in its absence would burn up all life on our globe.

See also WEATHER; CLOUDS; RAIN; SNOW.

WAVE MOTION. 1. This is perhaps the most important kind of movement in the universe. Without it there could be no light, nor heat, nor sound—in fact it is doubtful whether matter of any kind could exist in its absence. The waves we see on the surface of water are one example; but in its fullest sense wave motion means the sending of any regular disturbance (i.e. of energy)—through a medium of some sort. The waves by which we hear SOUND (q.v.) usually travel through the air.

In wave motion the medium itself does not move as a whole; but the particles composing it bounce to and fro about a middle position, passing on the disturbance to their neighbours until the end of the medium is reached or the energy is exhausted and dies away. There are two kinds of wave motion—'transverse' (to and fro sideways) and 'longitudinal' (or backwards and forwards). A snake wriggles transversely; but an earthworm moves more by the longitudinal method, passing waves of contraction right along the length of its body and alternately pushing its head out forwards and drawing in its tail behind it. We can easily make transverse waves by giving a sharp shake to one end of a long rope lying on the ground—when the waves

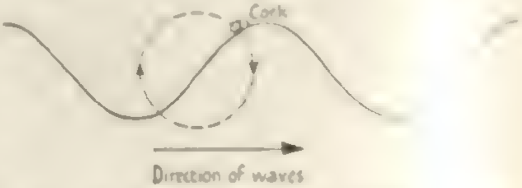


FIG. 1. THE DOTTED LINE SHOWS THE MOVEMENT OF A CORK FLOATING ON THE WAVES OF THE SEA

will travel along to the other end. The waves of the sea are of this kind and, like the waves in the rope, the water in them does not really travel forwards as it appears to do. Fig. 1 shows the movement of a cork as the waves travel past it: each particle of water follows a similar path, eventually coming to rest, when the waves have died down, just where it started. The effect of longitudinal waves can be shown by putting two pennies touching each other on a table top, pressing one of them hard down with a finger-tip so that it cannot move, and then tapping it on the side farther from the loose coin by sliding

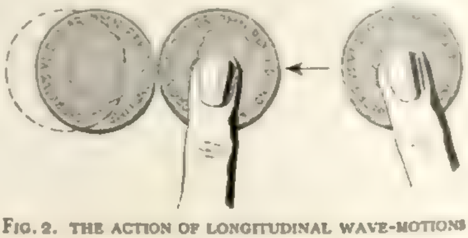


FIG. 2. THE ACTION OF LONGITUDINAL WAVE-MOTIONS

a th penny sharply against it (*see* Fig. 2). The will be transmitted by wave motion th fixed penny with enough force to m se penny jump away, although the wave mselves will be far too small to be seen. Here metal of the coin is the medium which passe m on.

W notion is measured in 'wave-length', or th e from crest to crest or trough to

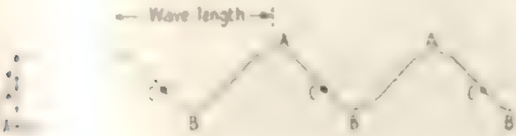


FIG. 3 -LENGTH AND AMPLITUDE. AAA (ALSO BBB AND C RESPECTIVELY) ARE IN PHASE

trough the waves (*see* Fig. 3); in 'amplitude', or the eatest distance which a particle travels when laced by a wave (this equals half the distan rom crest to trough); and in 'frequenc or the number of waves per second. It foll that the forward speed of the waves is the requency multiplied by their wave-length. requency is generally stated in 'cycles per se i', a cycle being the whole movement of any e particle through one crest and one trough ck to its starting-point. Particles in the sa osition in the cycle and moving in the same c tion are said to be in 'phase'.

It is npossible to imagine waves travelling throug othing: and certainly the waves which cause nd cannot do so. If an electric bell is set rin g in a vessel from which the air has been sucked out, it cannot be heard even from a few inches away. One of the great difficulties met in studying LIGHT (q.v.) is that although it shows many of the peculiarities of wave motion, yet it manages somehow to cross the great emptiness of space on its way to us from the sun and other heavenly bodies. Scientists have therefore had to make a compromise (at least for the time being) and, while dealing with most aspects of light as though they are due to wave motion, assume that in other ways light is conveyed by the movement of tiny bodies. The same is true of the other forms of energy, such as X-rays, heat, and wireless, described in the article on RADIATION (q.v.). The following properties are common to all kinds of wave motion.

2. REFLECTION. If we fix one end of a rope and then send a wave along it by giving the free end a shake, the wave will be reflected from the fixed end and will travel back along the rope to our hand. Sea waves can be seen to be reflected back from a cliff in a similar way. If the surface of the cliff is very uneven or the waves very small, they will be broken up and not reflected back. The waves of light are very small—less than a needle-point from crest to crest—and so they can be reflected efficiently only from smooth polished surfaces such as mirrors (but it should be remembered that every body we see, except an actual source of light, we see only by the broken light it reflects back to us). When light or any other wave motion strikes an ideal reflecting surface, it leaves it at exactly the same angle in the opposite direction, like a billiard ball rebounding from the side of the table (Fig. 4). Everyone is familiar with the reflection of sound, which is called an echo.

FIG. 4. ANGLE A AT WHICH THE BALL HITS THE SIDE EQUALS ANGLE B AT WHICH IT REBOUNDS, AND C EQUALS D

3. REFRACTION. When any wave motion passes from one medium to another of different density (as from air to glass or from air to water) its path is bent. This is because the two mediums offer different resistances to the movement of the waves. A parallel to this is the way in which the waves of the sea change their direction as they approach the land—the greater resistance of shallower water tends to swing them round and make them move straight inwards towards the shore, although in deep water they take their direction from that of the wind. Fig. 5 shows how, owing to refraction, a fish in a stream always looks nearer the surface than it really is. Natives who shoot fish with arrows have to allow for refraction, by aiming not at the fish, but well to the near side of it.

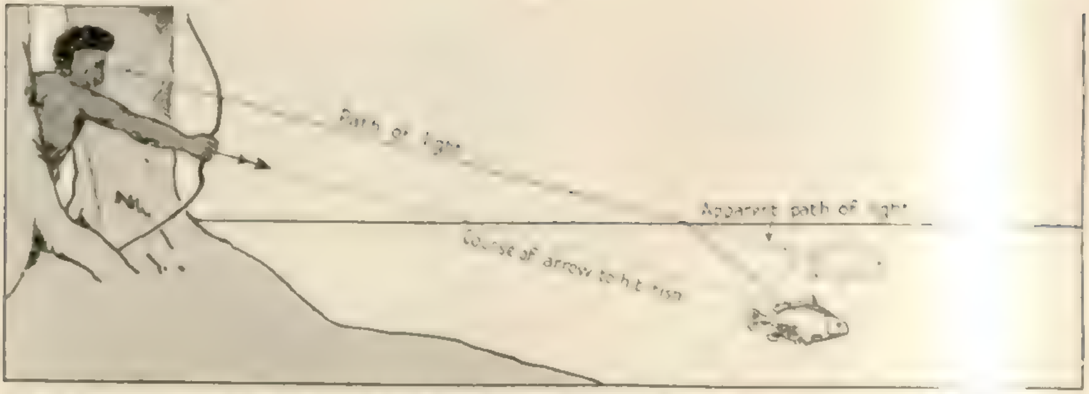


Fig. 5. THE FISH APPEARS TO THE NATIVE TO BE HIGHER THAN IT REALLY IS, BECAUSE THE LIGHT FROM IT [illegible]ED ON COMING OUT OF THE WATER

We see this if we hold a straight stick obliquely half in and half out of water, when it will appear bent, or if we look through a glass jug full of water, when everything will appear distorted. The property of refraction is made use of in such things as lenses for cameras, telescopes, and microscopes, which bring the rays of light to a focus as required and so form large and small images of the object. Lights of different colours are, because of their different wave-lengths, refracted at slightly different angles (*see* Colour). For examples of refraction in nature *see* Rainbow; Mirage.

4. Diffraction. This must be carefully distinguished from refraction. If a series of waves meet an obstacle in their path or pass through a

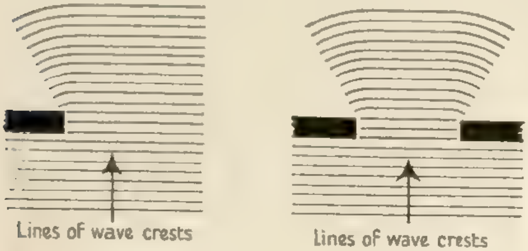


Fig. 6. DIFFRACTION. WHEN WAVES PASS AN OBSTACLE THEY SPREAD OUT BEYOND IT

narrow slit, they curve to a certain extent and spread out beyond it (*see* Fig. 6). The fact that we can hear round corners proves that sound is diffracted; but because we cannot see round corners it might be thought that light is not. However, light does turn corners, or is diffracted, but to a much smaller extent than sound. The amount of diffraction has been found to depend on the wave-length, being greater where this is longer and less when it is shorter. We can prove this variation for ourselves with sound by listening to a high whistle on the wireless and noticing how this varies in loudness as we turn an ear either directly towards the instrument or away from it, whereas with a low note (i.e. of longer wave-length) the effect is much less. The wave-length of all sound is comparatively great (for middle C it is 120 cm.), but that of light is extremely small, being only 0·00007 cm. for red light, the longest. Also, with light, diffraction is rarely noticeable unless the source of the light used is very small. An example of diffraction in nature is the 'corona', a coloured ring occasionally seen round the sun or moon when shining through light cloud or mist (*see* Rainbow).

5. Interference. When two or more sets of wave motion meet, they interfere with each other. Where the crest of one wave coincides with the crest of another, they reinforce each other; but where a crest meets a hollow, the two waves cancel each other out to a greater or less extent according to their different heights and depths (*see* Fig. 7). If two small sources of light of the same wave-length, strength, and phase are placed close together, they will interfere with each other in this way and produce alternate bands of light and shadow, called 'interference bands'. By measuring the size of these, it is possible to calculate the wave-length of the light. If sunlight is used, the bands will be bluish on one side and reddish on the other, because the colours of the spectrum have different wave-lengths. The rainbow colours which can often be seen in very thin films of liquids, such as when oil has been spilled on a wet road, or even in a

thin film of air between two pieces of glass times called Newton's Rings), are also due terference between the different wave- s found in sunlight. Similar bands can be hen light is diffracted round an obstacle ugh a slit.

es of sound interfere with each other in e way as those of light. If two adjacent the piano, such as C and C♯, are played r, we hear an unpleasant jarring sound. because in addition to hearing the two emselves, we also hear a certain number nd soft 'beats' per second, as shown in F 7. The closer together the two notes, the

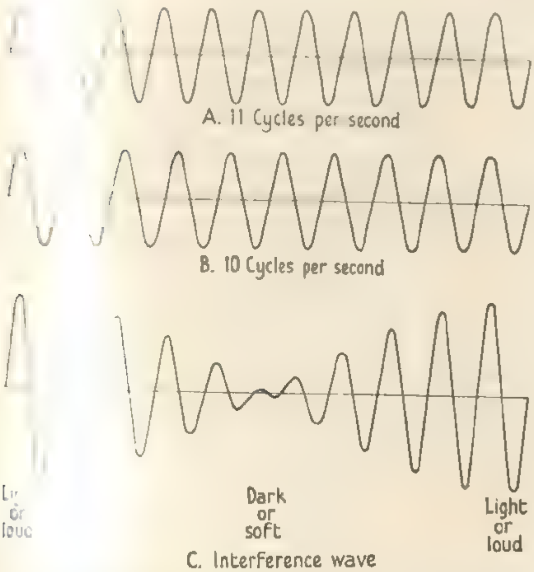


FIG. 7. INTERFERENCE. IF TWO LIGHTS OR SOUNDS WITH WAVE PATTERNS A AND B INTERFERE THE RESULTING WAVE PATTERN WILL BE C

less frequent these beats, and if they occur in the neighbourhood of 20 or 30 per second, the result is very unpleasant. If we listen in to Big Ben striking on the wireless, it is easy to pick out a slow 'boom-boom-boom' as well as the main note, because a big bell such as this sounds on more than one wave-length. The 'wang-wang' we hear when a multi-engined aircraft flies overhead with its engines not all going at exactly the same speed is also caused by interference.

6. DOPPLER EFFECT. Almost everyone has noticed, when an express train approaches blowing its whistle, or a fast car sounds its horn, that just as it passes, the sound alters suddenly to a lower note. This is called the Doppler Effect and it is easily explained in terms of wave motion. When the whistle or horn is approaching, each pulsation of sound is sent out a little closer behind the previous one than it would have been if the source of the sound had been stationary. So the waves are crowded rather more closely together, or, to put it correctly, the frequency is raised. When the engine or car has passed, the reverse happens—the waves are stretched farther apart, the frequency lowered. As the 'pitch' (or relative highness or lowness) of a musical note depends on the frequency, the pitch is artificially raised while the vehicle approaches, and similarly lowered when it has passed.

Because of the much higher speed of light (186,000 miles a second as compared with sound's 1,120 feet) we cannot notice any Doppler effect with any moving light on the earth—otherwise we should see the head-lamps of a car bluer (i.e. of shorter wave-length) as it approached us and redder as it sped away. But in astronomy the Doppler Effect has been used to calculate the speeds with which some stars are moving towards or away from the earth, as shown by analysis of their light. Here again, then, is an effect which, like diffraction and interference, can be explained only by reference to wave motion. The same must be said of 'polarization', which is described in the article on LIGHT.

See also RADIATION; LIGHT; HEAT; SOUND.

WEATHER. Changes in weather are due to the attempts of the atmosphere to even out the differences in its PRESSURE (q.v.) which exist in various parts of the world. Just as the waves in water tend to die down and level out, so bodies of air at high pressure tend to flow towards wherever the pressure is lower, and thus to level out the variations. They could succeed in doing this—and the air everywhere would be calm, the weather unchanging—if it were not for the fact that the heat of the sun warms the atmosphere more over some parts of the globe than over others. As things are, there is a continuous area of low pressure round the Equator, where the sun's rays are most powerful, and areas of high pressure round the North and South Poles. The hot equatorial air expands and rises, while the cold polar air, being at higher pressure, flows towards the Equator to take its place. Thus

WIND (q.v.) is created, and in Figs. 4 and 5 of that article the main winds of the world are shown, complicated as they are by the rotation of the earth and by the great masses of land and water on the earth's surface.

People living in latitudes like that of Great Britain (50°–59° N.) are inclined to think of the weather as something which changes constantly, and to forget that over much of the world conditions are far more settled. This is because (as WIND, Fig. 3, shows) it is at just about latitude 60° that some of the cold, equator-seeking air from the polar regions meets the warmer pole-seeking air from the Equator, so that there is a more or less continuous conflict in progress, sometimes the polar air having the advantage, and sometimes the warmer air from the south-west. Another reason for Great Britain's very changeable weather is that these islands lie on the boundary between a very large expanse of water, the Atlantic, and the great land mass of Europe and Asia. Over the first, as over all oceans, the air tends to collect moisture quickly and warmth slowly; whereas over the land it collects less moisture, but is more quickly warmed by the heat of the sun, since this is reflected from land but absorbed by water. Our weather, then, is largely dependent on which type of air has moved over Great Britain. Fig. 1 shows the principal regions in which these 'air masses'—perhaps several thousands of miles across—originate, and also gives their broad characteristics.

FIG. 1. AIR MASSES

Now warm air is able to hold very much more moisture than cold air (*see* WATER-VA[illegible]), and if air is cooled by any means to th[illegible]int at which it can no longer contain its mo[illegible]e, this has to condense in some such form a[illegible]ds or rain. There are several ways in whi[illegible] may be cooled more or less quickly. [illegible]r air tends naturally to rise above cool[illegible] 'convection', because in being warm[illegible] has expanded (*see* HEAT, Section 3); an[illegible]ere is a general tendency for the lower air, [illegible]d by heat reflected or conducted from [illegible]arth's surface, to rise through the higher la[illegible]hich get less heat from this source. But as [illegible], the pressure on it becomes less and it i[illegible]ed to expand still more. If a gas expands [illegible] any heat being given to it from outsid[illegible]own temperature must drop (which is w[illegible] air suddenly let out of a bicycle tire feels [illegible]. So air which rises by convection is lia[illegible] to be cooled both by its own expansion an[illegible] contact with the cooler layers through [illegible]ich it rises. A third way in which air may [illegible]ooled is by being carried upwards in wind[illegible]rents which have struck obstacles on the e[illegible] surface, such as trees, buildings, and hill[illegible]his is usually the explanation of the cloud[illegible] rain so often seen over mountains, the air ha[illegible] been carried up to a height at which it has [illegible]d so much that it can no longer hold all th[illegible]ture it contains. A mass of cold, dense [illegible]hen struck by a warm wind, can act j[illegible]ke a mountain in deflecting the warm air [illegible]rds. Finally, air can be cooled either by co[illegible] into contact with colder air or by resting [illegible] surfaces which are themselves cold, such [illegible]s the oceans or snow areas of the arctic.

Weather, then, depends upon the interaction of all these complicated factors. Areas of high pressure are called 'anticyclones'. In these the pressure is highest at the centre, and so the winds tend to blow outwards towards where the pressure is lower. Owing to the rotation of the earth, however, all winds in the northern hemisphere are deflected to the right and in the southern to the left; so that in the former, the winds round an anticyclone blow in a clockwise direction, and in the latter they blow anticlockwise. As the air near the centre of an anticyclone is very still, local influences like sea-breezes, valley winds, and differences of temperature caused by local heating of the ground, make themselves felt and may create local changes of weather and even rain. But on the whole, anticyclones (which are

u..ally very large) bring a calm settled type of w..ather. The long, fine, warm spells in summer ... the cold spells of easterly wind in winter are ... to anticyclones centred somewhere over ...nental Europe, an area of intense heat in ...er and intense cold in winter. As you ...t expect from a glance at Fig. 2 in the ... on WIND, there is usually a large anti...e far out over the Atlantic to the south-west ...t Britain, centred somewhere near the ...nd reaching perhaps to Bermuda. This ... but very moist after its long contact with ...an. If the prevailing south-west wind ... this to us in summer, we probably have h... weather—though not so hot as when we get a...-cyclonic conditions from the dry heat of A... *see* Fig. 1). In winter, however, the same At... air mass may meet so low a temperature he... at it can no longer hold its moisture, an... ...m, but cloudy or rainy weather may res...

W... warm tropical air is brought alongside polar a... as often happens in our own latitudes, the res... is usually a 'cyclone'. As the word suggests, his is the opposite of an anticylone in every wa... It is an area of low pressure; so the winds ten... to blow towards its centre and are therefor... deflected by the earth's rotation anti-clock... in the northern hemisphere and clock-wis... the southern. A cyclone, which is usually m... smaller than an anticyclone—though there ... usually a succession of them—is formed by the movements of great air masses. It is quite impossible for two masses of air at different temperatures to flow side by side for long: so when a mass of warm tropical air meets a mass of cold polar air—as often happens over the Atlantic—they mix and form a cyclone. Fig. 2 shows how this happens. First a wave or wedge of warm air pushes its way into the cold (Fig. 2*b*). Eventually the cold wind sweeps right round behind it (Fig. 2*d*), cutting it off from the main mass of warm air. The storm is now formed and the circle of local wind is complete. Meanwhile the whole system is moving along a definite track—usually towards the north-east with us, since our prevailing wind is south-west. Eventually the cold air raises the circle of warm air right off the ground, forming what is called an 'occlusion'. From what we have just read it is clear that such happenings may well result in condensation and rain. The weather accompanying cyclones is generally unsettled and often extremely violent—in fact, the word is also used to describe a particular type of storm (*see* HURRICANE).

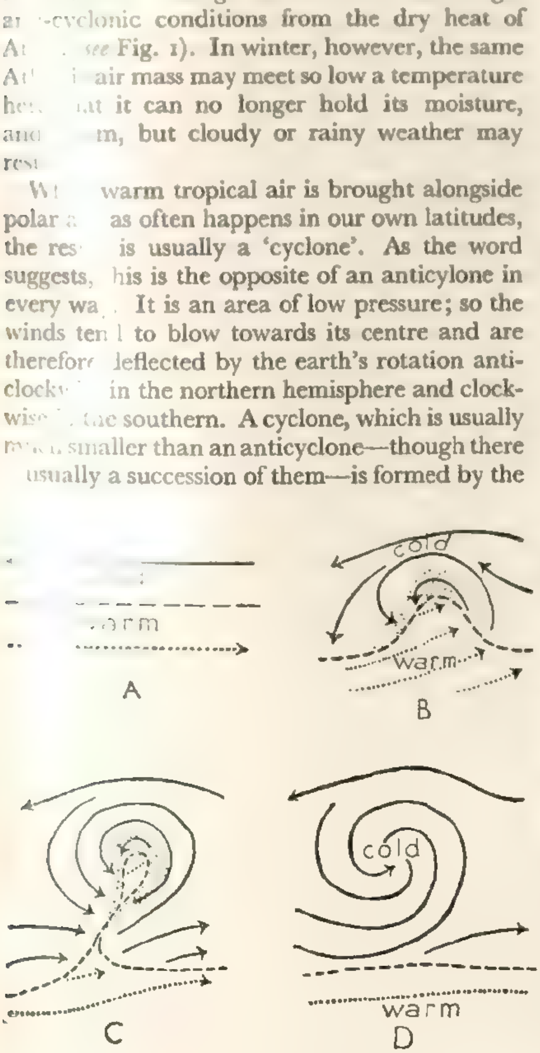


FIG. 2. THE GROWTH OF A CYCLONE

The approach of a body of warm air (a 'warm front', or an 'occluded front' if it has been cut off from the ground) is signified by a freshening of the wind from a southerly direction. Then the sky becomes covered with a thin film of cloud which increases in thickness until heavier rain clouds appear, and a steady downpour begins, usually accompanied by a strong wind. When the warm front has passed, there is often a clearance of cloud and there may be a fine spell; but as the 'cold front' at the rear of the depression approaches, heavy downpours are frequent. During one of these, the wind veers to a westerly or even a north-westerly point, and the sky begins to clear. It becomes colder and dry, except for a few scattered showers of rain.

Cyclones often travel in threes with a short interval of fair weather between. Their own speed averages from 10 to 30 miles an hour; but this bears no relation to the speeds of the winds blowing round them, which may reach gale force. Anticyclones are far more sluggish, and may remain almost stationary for days or even weeks. 'Depressions' or areas of low pressure are not always cyclonic in form: they may be in the shape of wedges or V's and are often described as such in the weather reports. 'Secondaries' are depressions following the first one. Usually they

are smaller, but on occasion they develop and become larger. Cyclones, anticyclones, and V-shaped depressions can all be seen in Fig. 1 of the next article.

See also WEATHER FORECASTING; CLIMATE; CLOUDS; WIND; RAIN; SNOW.

WEATHER FORECASTING. Broadcasting has made the official Weather Forecasts familiar to most of us; and those who live in the country, at least, have also come across weather-wise folk who have their own ways of foretelling to-morrow's weather. We are not long in learning that both types of prophecy are apt to be proved wrong—and we may wonder at times if the official forecast is so very much better than that of the countryman who knows 'the signs' or, in fact, if there is much trust to put in either of them. The answers are to be found partly in the preceding article, WEATHER. We read in this that changes in our weather are really due to the movements of great 'air masses', perhaps thousands of miles in extent, some of which may contain cold and dry (or cold and wet) air at high pressure, and others warm and damp (or warm and dry) air at low pressure. It is obvious, then, that we cannot hope to forecast the weather for more than a few hours ahead unless we know what air masses there are about, which of them are moving in our direction, and how fast they are moving—and know all this for a distance of several thousand miles round.

As we shall see, the official weather experts do know all this and a great deal more; so it is reasonably safe to trust their forecasts on most occasions. The main reasons why they sometimes prove quite wrong is that, from causes usually beyond our understanding, the air masses themselves cannot always be relied on to do what they appear likely to do. An anticyclone approaching at an average speed of 20 miles an hour may change its course or speed, or become stationary; a depression may fill up unexpectedly and disappear; or a secondary may deepen and bring far worse weather than was anticipated. No doubt as the network of weather-reporting stations increases, and as more information is sought from the upper atmosphere, these set-backs will become rarer; but the factors affecting our weather are so many, and cover so vast an area of the globe and so great a depth of the atmosphere (even if we leave out of account such influences as sun-spots), that forecasts are never likely to achieve perfect accuracy.

There have no doubt been weather-prophets since the very early days of man; but anything like scientific forecasting had to wait until the necessary instruments had been invented. The most important of these is the barometer, which measures the PRESSURE (q.v.) of the atmosphere. Very soon after the invention of this, i… people noticed that a fall in atmospheric pressure usually meant a change for the worse in the weather, and before the end of the century familiar dials marked 'Very Dry', 'Set Fair', 'Fair', 'Changeable', 'Rain', 'Much Rain', and 'Stormy' were being made. Many of these 'weather-glasses' also contained a 'hygrometer' for measuring the humidity of the air—i.e. the amount of WATER-VAPOUR (q.v.) in it. The thermometer, for measuring the temperature of the air, had been invented by GALILEO (q.v. Vol. V) at the start of the century; but though this was fitted to many barometers, it was not much use for meteorological purposes when kept indoors. These three instruments, with the 'anemometer', which measures the speed of the WIND (q.v.), are still the principal tools of the meteorologist. The one last thing he needed was some means of finding out quickly what the weather was like hundreds of miles away from his own station. This the 19th century gave him, in the electric telegraph—to which the 20th century added the even more convenient wireless.

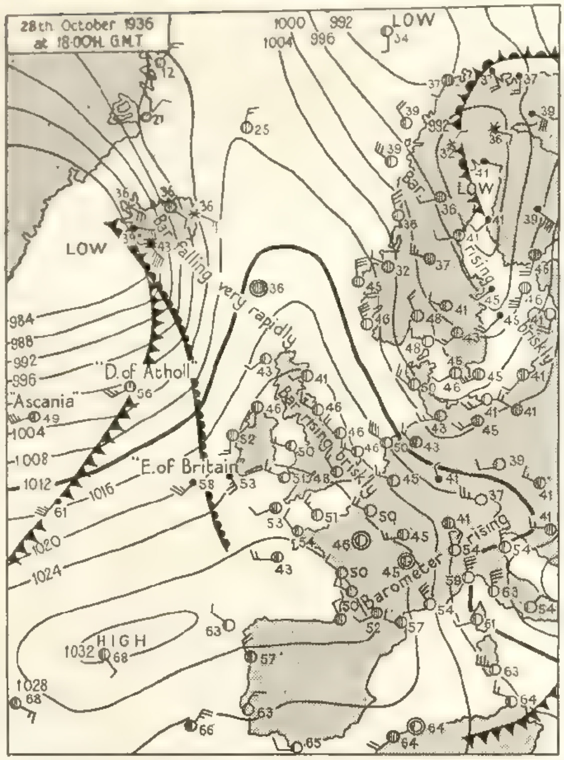
Let us now see how our official weather forecasts are made. There are in Great Britain some 200 weather-reporting stations, and a… the same over the rest of Europe; … takes full observations at least four times a day, as do a number of special 'weather ships', owned by different nations and stationed in various parts of the ocean. Certain ordinary ships also transmit four reports a day while at sea, and the Air Ministry sends aircraft out daily on 'met. flights' from Britain and Gibraltar. All this information is sent by wireless and teleprinter to the Central Forecasting Office, who receive it within a very short time of the readings being taken. A selection of it is re-broadcast at once for the benefit of other meteorological stations; but the main task is to get it plotted on a chart as quickly as possible, so that by comparing this with the previous charts, the weather experts can work out their forecasts.

The blank chart is simply a large map, taking

in the whole of Europe and the North Atlantic, with bits of America, Asia, and North Africa. About 350 black circles represent the positions of weather stations, whose reports are to be plotted against them. Special symbols are used as shown in Fig. 1. When this has been done, the next step is to draw in the 'isobars' or lines joining up places where the barometer readings (all corrected as though they had been taken at sea-level) are the same. The result is rather like a contour map showing hills and valleys of higher and lower pressure instead of real hills and valleys. From this, the position of 'lows' (or 'cyclones') and 'highs' ('anticyclones') can be easily seen. Next, by comparing the various reports of temperature, lines are drawn showing the positions of the various types of 'front' ('warm', 'cold', and 'occluded'—a warm front that has been lifted right off the ground by a cold front). Finally, areas of rain, snow, or fog are marked in.

In about three hours from the time of the original observations, all this comparatively unskilled work (usually called 'plotting') is done, and the weather experts can start the difficult task of deciding what the weather for the next twenty-four hours is likely to be. Fig. 1 shows what the maps they are given now looks like. It is called a 'synoptic' chart, meaning one which gives a general view. By comparing this with the preceding charts they can see the position and movement of the 'highs', 'depressions', and 'fronts'; and they can judge how they are developing—whether becoming more or less intense. If everything always proceeded according to the signs, their work would not be too difficult; but as we have seen, it does not—and so there is the greatest scope for judgement and experience in reading the probabilities. Apart from quickness to notice very slight indications of possible changes, meteorologists also work to some extent on the fact that weather tends to get in certain 'moods' and keep on doing the same thing over and over again, even though the physical readings do not quite suggest this in advance. In fact, a successful forecaster cannot afford always to work entirely by set rules: he must also be prepared to work by instinct or feeling.

Forecasts made in the way described cannot be trusted—and are not intended to be trusted—for more than three or four days ahead. Long-term prospects are usually based on a



BAROMETER: Isobars are drawn for intervals of four millibars.
TEMPERATURE: Given in degrees Fahrenheit.
WIND: Direction is shown by arrows flying with the wind. Force, on the Beaufort Scale 0–12 by number of feathers, a long feather denoting two steps on the scale, a short feather one step.
WEATHER SYMBOLS: ∞° Slight haze. ≡° Mist. ≡ Fog.
Sky less than ¼ clouded. Sky ¼ to ¾ clouded.
Sky more than ¾ clouded. Sky overcast. ○ Calm.
• Rain falling. ▲ Hail. T Thunder. Thunder-storm.
Warm front. Cold front. Occluded front.

FIG. 1. A SYNOPTIC CHART

rather different system, and though they cannot be relied on so much for any particular day, in the past few years they have been fairly successful in prophesying the general type of weather to be expected for some weeks ahead. These forecasts are made partly by working from the average weather of the particular period taken over a large number of years, and partly by hunting through old synoptic charts until a series is found closely resembling those of the moment. If such charts can be found, the weather which followed their dates gives a good indication of the weather to be expected presently. No doubt in time charts will be indexed and filed in such a way that the closest parallels can be hunted out immediately—much as Scotland Yard has succeeded in filing finger-

[illegible]. We must remember, too, that although [illegible] a century [illegible], the first chart that can be called synoptic did not appear until the [illegible] of [illegible]—so that there are not yet many accurate records to draw on.

After reading so far, the reader may feel that it is no use trying to become anything of a weather prophet since he can have no elaborate charts and no instruments beyond a barometer [illegible] to help him. But this is by no means true. If he will form the habit of watching the signs and noting what weather usually follows them in his district, there is no reason why he should not reach a very useful level—especially if he will read enough on the subject to learn the rudiments of it. The following general notes will help a little. The most useful weather signs are CLOUDS (q.v.), in the article on which are given many indications of the sort of weather portended. As some high clouds may give warning of a depression while it is still the best part of 1,000 miles away, there is clearly no need to regret the lack of a synoptic chart too bitterly. It is the change of type of cloud that should be looked for, rather than a change in amount. Next in importance, perhaps, comes the colour of the sky. This is deepest when there is least humidity in the air, a pearly greyness betokening moisture, and 'haloes' (*see* RAINBOW) the probability of rain. Nature provides plenty of hygrometers by which the humidity can be checked. A piece of seaweed hung up will feel crisp or limp according to the moisture in the atmosphere—so will many people's hair. The scarlet pimpernel (the Poor Man's Weather-glass) shuts its petals when the humidity reaches 80%, below which figure one is at least safe in saying that rain is unlikely. People with corns or rheumatic joints, both of which are usually painful on the approach of wet weather, would gladly sacrifice their conscientious hygrometers. The saying, 'A red sky at morning is the shepherd's warning' is often right, because the red colour is caused by the greater scattering of the waves of light owing to the presence of moisture particles (*see* COLOUR). On the other hand, 'The red sky at night is the shepherd's delight' proves right two out of three times, because the scattering at that time of day is due to a high proportion of dust particles such as hang in the air in fine settled weather. A yellow sunset is an equally accurate portent of rain, while a green sky means stormy weather, [illegible] five.

If you have a barometer to look at, [illegible] that the old markings of 'Rain', 'Change' and so on mean very little. It is the movements of the finger that count, not the word it is pointing at. Also the more slowly the pressure changes, the more lasting is the subsequent weather likely to be—'Long foretold, long last; Short notice, soon past' as the verse puts it. Lastly, remember that the actual position of your home may influence the sort of weather you get, so that you may be able to learn with experience how to modify even the official forecasts to something nearer the truth so far as they concern your immediate district. This is particularly so if you live in hilly country, or near the sea.

WEATHERING (GEOLOGY), *see* DENUDATION, Section 1.

WELLINGTON. The capital of New Zealand, situated at the south end of the North Island, is conveniently placed for administrative purposes. In 1865 its central position led to its selection as capital instead of Auckland which, although the largest city and port, was too remote from the rest of the islands for convenience. The Governor-General lives in Wellington, and all the principal government buildings are there, including the Parliament Buildings, in which the elected House of Representatives and the Legislative Council sit.

Wellington has a population of about 135,000, and is the second largest city and port in New Zealand. It is linked with the rest of North Island by the Main Trunk Railroad, and with South Island by daily services of ocean-going ferry steamers. There is also an airport at Rongotai near the city.

Architecturally, Wellington is a curious mixture of wood, stone, and concrete, in a variety of styles—earthquake-proof modern public buildings rising amid a jumble of Victorian wooden structures. Its streets are steep, as they must be in a town that is built terrace-fashion on hills surrounding the magnificent harbour, and it is haunted by mischievous winds which sweep down the roads and round the corners, giving it the name of 'Windy Wellington'. As in most New Zealand towns, the country is within easy reach, and the inhabitants from nearly any position in the city can see the

blue waters of the harbour, and the slopes of the surrounding green hills—golden, sometimes, with gorse in [illegible]

See also [illegible]

WELLS AND SPRINGS. Wells and springs are fed by underground water. When rain falls, some of it runs away as streams and rivers, some evaporates, and some sinks into the ground and becomes underground water. The amount that sinks into the ground depends to a very large extent on what sort of rocks are there, whether they are 'pervious' and allow water to pass through or whether they are 'impervious' and do not. It also depends largely on the presence or absence of trees and other vegetation which screen the water from evaporation and hold it in their sponge-like root systems until it has time to soak into the ground (*see* SOIL EROSION).

Pervious rocks are of two main kinds: those that are porous (gravels, sands, most soft sandstones, soft limestones, and chalk) and give passage to water by thousands of little pores between the rock grains, and those that are not porous (crystalline rocks) but allow water through by cracks and joints. Porous rocks are not all pervious—clay is porous, but it is impervious, because its pore spaces are too small to allow water to pass through.

The sinking of water through the ground is stopped either when it meets a bed of impervious rock or when it reaches the depth at which rock pressure has become so great that passages through the rock are closed. Above these limits there is a belt saturated with water. The upper edge of this belt is called the 'water-table'. Its distance from the surface varies from place to place and from season to season. Wells are fed by the water of this saturated belt and fill to the level of the water-table. Some wells are not deep enough to reach the water-table all the year round and, consequently, contain water for only part of the year. Such wells are said to be intermittent (*see* Fig. 1).

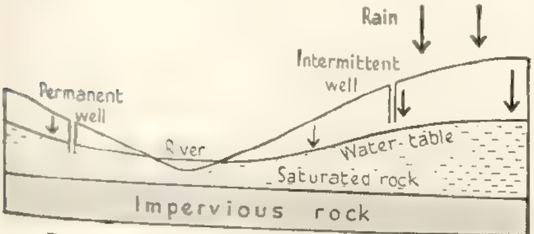


FIG. 1. PERMANENT AND INTERMITTENT WELLS

A SPRING IN PALESTINE CAUSED BY A WATER-BEARING BED COMING TO THE SURFACE. *Matson Photo Service*

The water from wells is raised to the surface of the ground by pulleys or pumps. In artesian wells, however, the water rises by itself. Artesian wells take their name from Artois in France where the first wells of this type were struck. They can occur only when a water-bearing bed is sandwiched between two impervious beds in the form of a U (*see* Fig. 2). When a well is bored to the lower part of the bed, water is forced up the shaft by the pressure or 'head' of water in the higher parts.

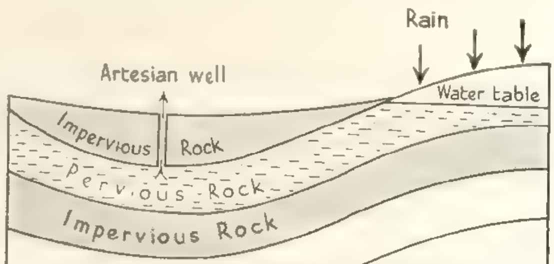


FIG. 2. AN ARTESIAN WELL

The London area is an outstanding example of an artesian area, and many hundreds of such wells have been bored. So much water, however, has been drawn off owing to the growth of

London in the past century, and so much of the Chiltern and North Downs through which the rain-water sank has been covered with houses and roads that now there is no longer sufficient water to rise in the wells, and pumps have to be used to raise it to the surface.

In the U.S.A. there is an artesian area of over [illegible] square miles in North and South Dakota. But the largest artesian area in the world is in Australia, where over an area of about [illegible] square miles in parts of Queensland, New South Wales, and South Australia, water which fell in the eastern highlands rises in wells some of which are over 4,000 feet deep.

Springs occur where the water-table comes to the surface of the ground, e.g. along the sides of hills and valleys or in hollows (*see* Fig. 3 *a*). They occur, too, where faulting has broken the impervious rock above a water-bearing bed, as shown in Fig. 3 *b*. In this case, a natural artesian well is the result. Sometimes, as in desert oases, water-bearing beds which collect their water hundreds of miles away bend up and reach the surface, to form a spring.

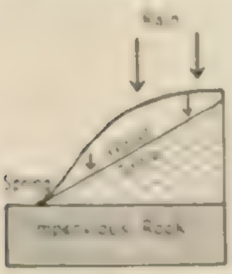


Fig. 3 *a*

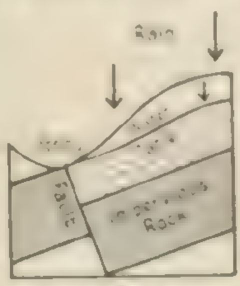


Fig. 3 *b*

WEST AFRICA, *see* ANGOLA; BELGIAN CONGO; GUINEA LANDS; NIGERIA.

WEST INDIES. The term 'West Indies' was given to the islands of the Caribbean Sea by their original discoverers, Christopher COLUMBUS (q.v. Vol. V) and others, because, when they found them, they thought they had reached the east coast of India by the western route. Columbus continued to think this to his dying day. The name has persisted, and is now generally and rather imprecisely held to apply to that chain of islands, large and small, which runs in an arc—indeed, almost a right angle—from the tip of the Mexican peninsula of Yucatan to the eastern end of the coast of the South American republic of Venezuela and separates the Caribbean Sea from the Atlantic Ocean. Its largest island, Cuba, also separates the Caribbean Sea from the Gulf of Mexico. That part of the right angle which runs east and west contains the four largest islands—Cuba, Jamaica, Hispaniola, and Puerto Rico—and forms the chain of the Greater Antilles; that part which runs north and south is made up of much smaller islands and is known as the Lesser Antilles. The Bahama Islands lie in the Atlantic Ocean to the north of Cuba and Hispaniola and are rather doubtfully 'West Indies', and the BERMUDAS (q.v.) are strictly no part of the West Indies at all. For certain purposes the two mainland colonies—British Honduras in Central America, lying on the Caribbean, and British Guiana in South America on the Atlantic—are grouped with the British West Indian island colonies; while the three Dutch islands of Curaçao, Aruba, and Bonaire, although geographically outliers of the South American continent, are also regarded as West Indian and form a part of the same colony that includes the Dutch Windward Islands in the Lesser Antilles.

The West Indies have changed hands a good deal during the course of their history, according to the fortunes of war between the main colonizing powers—Spain, Britain, France, Holland, and latterly the United States. Spain, who was first on the field, lost the last of her West Indian possessions in the Spanish-American War of 1898. The present distribution of the West Indian Islands is as follows.

- Independent Republics—Cuba, Hispaniola (Haiti, and the Dominican Republic).
- Britain—Bahamas, Jamaica, Leeward Isles (Antigua, St. Kitts-Nevis, Monserrat, and British Virgin Isles), Windward Isles (Grenada, St. Vincent, St. Lucia, and Dominica), Barbados, Trinidad, and Tobago.
- France—Guadeloupe, Martinique, St. Bartholomew, small islands of Lesser Antilles.
- Holland—Curaçao, Aruba, Bonaire, small islands of Lesser Antilles.
- U.S.A.—Puerto Rico, American Virgin Isles.

Britain, France, and Holland have also colonies on the mainland of South America (*see* GUIANAS).

The West I[illegible] within the tropics. [illegible] modified by their [illegible] not a great difference [illegible] winter and summer, [illegible] are dry and the [illegible] in the track of the [illegible] heavy rain to the [illegible] the end of the [illegible] storms called H[illegible] ships ashore and sweep [illegible] plantations. Some of the island[illegible] [illegible]mas and Barbados, are of [illegible] (CORAL ISLANDS), but the ma[illegible] origin. Many of the island [illegible] landlocked, being craters of [illegible], and there are volcanoes, [illegible] in Martinique and [illegible], which have continued to [illegible] active into the 20th century. [illegible] instance, towards the beginning of the [illegible]tury, made a sudden violent eruption, and [illegible] a few minutes completely destroyed [illegible] city of St. Pierre.

The islands are [illegible] to be the summit of a submerged [illegible] range, the Caribbean Andes, wh[illegible] the two halves of the Ameri[illegible]. Their greatest height above sea-[illegible] [illegible]000 feet, is attained in Hispaniola [illegible], at the point where British Gu[illegible] and Venezuela meet, which rises [illegible], is part of the same range. Th[illegible] and other mineral springs in [illegible] the islands, and th[illegible] are oil deposits in Tri[illegible] and Barbados. Trinidad also possesses the [illegible] and profitable [illegible] phenomenon, an asphalt lake, La Brea, up[illegible] whose dark surface men are at work digging up the ASPHALT (q.v.). Trinidad is also the most important oil-producing territory in the British Empire.

The West Indian Islands depend economically in the main on tropical agriculture, and the staple crop of the region as a whole is the sugar-cane, from which are derived not only sugar, but molasses and rum. Cuba is one of the leading sugar-producing areas of the world. The sugar plantations look like miniature forests, with their long, narrow, knife-edged leaves and bamboo-like stems, growing so close together that there is no room to move. Cuba is also famous for its Havana cigars, the most highly prized cigars in the world. Other West Indian products include cotton, bananas, arrowroot, cocoa, coffee, nutmegs, and vanilla. The picking season of bananas in particular—as in Jamaica—is a very busy time, and most picturesque. The negro women in brightly coloured dresses, with gay head kerchiefs and big silver bracelets, wrap the bunches of bananas in the wide jade green leaves and carry them on their heads, to pack them in rough wooden crates in which they are taken to the port and loaded on fruit-boats. Along the rough winding inland roads, donkey-carts or donkeys laden with heavy baskets slung on their sides are continually passing along under the shade of coco-nut palms or through avenues of giant bamboos.

Oranges are exported from Curaçāo to Holland to be made into a valuable liqueur. St. Vincent, St. Kitts, Monserrat, and Barbados specialize in sea-island cotton. Puerto Rico is renowned for its straw hats. The coral islands, with their palm-fringed coasts and golden sands, produce COPRA (q.v. Vol. VII), a product of the coco-nuts; and on the Bahamas, which are flat and wooded, tomatoes,

THE WEST INDIES

TOBAGO, AN ISLAND OF THE BRITISH WEST INDIES *Dorien Leigh*

pine-apples, and citrus fruits are grown, and sponges are collected by divers from the coral rocks and exported. Hispaniola is very mountainous, and its interior is still largely unexplored. The western part of the island, Haiti, is a negro republic, and its chief crop is sugar. The eastern part is the republic of Dominica, peopled almost entirely by Creoles (Spanish or negro settlers), and its staple crop is limes, of which it produces the best quality in the world.

See also Vol. I: West Indians.

WESTPHALIA, *see* Germany.

WHIRLPOOL, *see* Tides.

WHIRLWIND, *see* Tornado.

WILL-O'-THE-WISP. This (or Jack-o'-Lantern) is the common name for a curious light that is sometimes seen in marshy places and churchyards at night. Its scientific name is *ignis fatuus* or 'foolish fire'. Many superstitions have grown up about it and many tales have been told of tired travellers being lured to their deaths in bogs by what they took to be the guiding light of another wayfarer or the lighted window of some safe shelter. In Ireland it is believed to be a soul which has escaped out of Purgatory; in Germany it is taken for the spirit of a baby that has died before being christened.

Very different descriptions of the Will-o'-the-Wisp are given by different observers. It is most commonly seen in autumn, not very long after nightfall. The light may be almost [illegible], but is never white. It may stay still, either near the ground or a few feet above it; it may bob or dance about, sometimes dividing into several flames, or it may bound rapidly [illegible] country-side, now high in the air and now close to the ground. It has been said to retreat if you follow it, but to follow you if you walk away from it.

One might think from their Latin name for it that scientists have dismissed the light as mere superstition; but although many instances can no doubt be explained away as imagination, as lights of distant houses, as glow-worms, or as decaying matter (which does sometimes become phosphorescent and glow in the dark), there are accounts which cannot be reasonably doubted. Two German physicists at different times have studied Will-o'-the-Wisp at close quarters. One held his hand in it and felt no heat. The wind blew it out and it relighted a moment later with a faint 'plop'. The other held the end of his walking-stick in it for a quarter of an hour, since

the bog prevented him getting closer; when he [illegible] the metal ferrule was still quite cold. [illegible] cases seem to prove that the explana- [illegible] be lighted 'marsh gas' (*see* GAS, [illegible] even if this gas could set alight to [illegible] seems impossible. Any probable [illegible] gas known would have a strong [illegible] smell has ever been reported. In [illegible] small waft of gas could continue [illegible] my minutes and at the same time [illegible]. It seems that we shall [illegible] an explanation until someone [illegible] mining Jack-o'-Lantern's light [illegible] spectroscope (*see* COLOUR).

[illegible]-Wisp is seen less often to-day [illegible]. No doubt the continued draining of [illegible] fens has contributed to this, many place[illegible] where it was once not uncommon being now [illegible] ground. It has been reported from many [illegible] of the world, but particularly from Germ[illegible], Italy, Ireland, Scotland, and the west and [illegible] of England.

See [illegible] MOORLAND AND MARSH.

WIN[illegible]STER. This historic city, the old capit[illegible] England in Saxon times, stands on a grou[illegible] chalk hills on the River Itchen in Ham[illegible] about 12 miles from the south coast. The [illegible] High Street twists steeply down from [illegible] West Gate, one of the two remaining ancie[illegible] of the city. It runs past the tall 15th-c[illegible] City Cross, the Tudor houses, and moder[illegible], to the wide square where stands the [illegible] Statue of King ALFRED (q.v. Vol. [illegible] capital city this was.

On the site of the present Winchester there proba[illegible] a very early British settlement. The B[illegible] name for the first town was Caer Gwen[illegible] City'. It became an important pla[illegible] Romans, for it was a centre of the R[illegible] roads of south England. The name Winchester came from a version of the Roman [illegible] Vinte-caster. Legend associates the city [illegible] King Arthur, and what pretends to be the original of the Round Table is shown among the old Winchester Castle relics. During the Middle Ages Winchester was of great importance. The castle was a favourite royal residence. King Canute and William Rufus were buried there, and Richard Coeur-de-Lion was crowned there, as well as in London. By the 14th century it had reached the height of its importance, being the chief wool market in

THE WEST GATE, WINCHESTER
Central Office of Information

England, and carrying on much trade with the Continent. From the 15th century it began to decline. It suffered severely in a siege during the 17th-century Civil Wars, and the castle was dismantled. Cromwell's soldiers treated the Cathedral with disregard, stabling their horses in its nave. Now it is a comparatively small country town, famous mainly for its historical associations, its magnificent cathedral, the boys' public school, Winchester College, and the regimental depot there. It was fortunate in escaping damage during the air-raids of the Second World War. Hitler is said to have been saving the city for his own coronation.

The Cathedral is the largest in England and one of the largest in Europe. It is dedicated to St. Swithin, who was bishop of an earlier Saxon Cathedral in the 9th century. A new cathedral was built in the 11th century, and this was greatly enlarged and rebuilt in the 14th and early 15th centuries. The two Norman transepts and the low central tower, as well as a very early crypt, remain of the earlier building. The Cathedral stands in the middle of the town, surrounded by a wide close and fine trees. Close to it is the College, founded by William of

Wykeham in 1382 and opened as a boys' school in 1394. This is one of the oldest of England's public schools, though its beautiful 14th-century buildings have been modernized and added to. It has continued an unbroken existence since the time of its foundation.

WIND. We generally use this term to describe only the horizontal movement of air across the earth's surface, for unless we are flying we are not likely to notice the upwards or downwards currents. All wind is caused by air moving from places where pressure is higher to where it is lower. The chief reason for there being areas of high and low pressure is that the sun does not heat the earth equally all over, much more heat being given to the Equatorial regions at the Equator than at the Poles. When air is heated, it expands and, becoming lighter, rises by what is called convection, so lowering the pressure

FIG. 1. [illegible] THE EARTH

near the ground and increasing it up above. This occurs all round the equatorial belt, with the result that the cooler high-pressure air from the polar regions sweeps in at low level, while the warm equatorial air moves outwards at high level towards the Poles. Here it is cooled and sinks, taking the place of the air now at the Equator. Fig. 1 illustrates the process and compares it with the circulation of water in a kettle.

But this is an over-simplified version: the warm equatorial air does not make its high-level journey to the Poles in one 'hop'. By the time it has got about a third of the way and reached latitude 30° (*see* Fig. 2), some of it has cooled sufficiently to bring it down towards the earth's surface again. Here it divides, part of it doubling underneath and drifting back towards its starting-point, and part of it regaining its original direction (but at a low level) and drifting towards the Poles. When this latter stream has done about another third of its journey and reached latitude 60°, it meets the stream

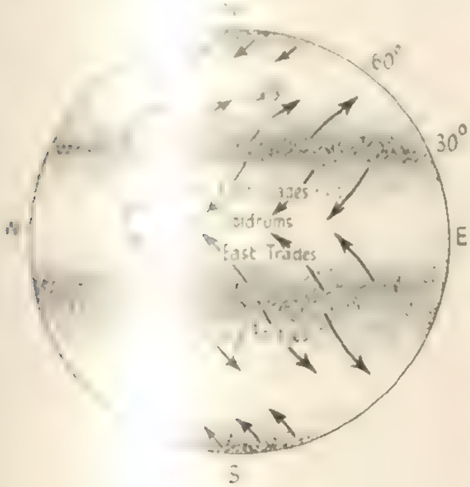
FIG. 2. [illegible] HEMISPHERE

of cold air moving from the Poles towards the Equator. It is forced to rise over the stream, being warmer, and so lighter, and begins its journey at a high level again. We see, then, that instead of one low-pressure belt along the Equator and two high-pressure areas at the Poles, there are also two intermediate high-pressure belts round about latitudes 30° north and south, and two low-pressure belts near latitude 60° north and south.

There is a further complication to be considered—the rotation of the earth. The distance round the Equator is about 25,000 miles; the earth rotates on its polar axis once in every twenty-four hours: and so its surface speed at the Equator is something over 1,000 miles an hour. This, then, is the speed of the equatorial air when it starts out on its journey towards the Poles. But the farther the air travels from the Equator, the slower becomes the speed of the earth beneath it, since each circle of latitude grows smaller—becoming nothing at latitude 90°, the Poles—though each takes twenty-four hours to make its rotation. As a result of this, the Pole-seeking air is continually rotating more quickly than the earth's surface beneath it. On the other hand, the Equator-seeking air from the Poles travels above a surface which is continually moving faster and faster, and so it is always lagging behind. The effect of this, so far as we on the earth's surface are concerned, is that in the northern hemisphere, since the earth rotates from west to east, a north-seeking wind blows towards the north-east and a south-seeking wind towards the south-west. In the southern hemisphere, the effect is reversed, a north-seeking

wind blowing t[illegible]ds the north-west and a [illegible]ards the south-east. Fig. 3 shows th[illegible]ct of this on the surface winds—and ex[illegible], incidentally, why the [illegible] Isles is south-west.

It explains, t[illegible]eral terms used by sailors to describe win[illegible]ions well known to them. The Doldrum[illegible]e central belt round the Equator. Here [illegible]d sailing-ships were often becalmed for [illegible] end, waiting for a wind. This is because [illegible]f the movement of the air



WORLD WINDS

there consists [illegible]up-and-down convection currents rather th[illegible] horizontal winds. The 'trade winds' prevail [illegible]he belts on either side of the Doldrums. The[illegible] blow in towards the Equator to take the pl[illegible]f the air which is always rising there, and a[illegible]egular that they could be relied on to ca[illegible] the sailing-vessels of the past for many hun[illegible]s of miles on their voyages. They helped Magellan in his great voyage across the Pacific and took Vasco da Gama to India after he had rounded the Cape of Good Hope. As their name suggests, it was the 'trades' on which trans-oceanic trading depended until the coming of the steamship. In the southern hemisphere, the 'Roaring Forties' are the counterpart of the South-Westerlies which bring us so many of our gales.

If there were no seasonal changes in the heating of the earth by the sun, and if the earth's surface reflected heat back equally from every part, Fig. 3 would be a fairly accurate chart of the world's winds at any time—and our weather would be a great deal less changeable than it is. But, as we know, the alternation of the seasons between the northern and southern hemisphere means that when one is having summer, with more heat, the other is in winter with less heat, and so on. This alone would be enough to upset our tidy pattern of winds. But beyond this again lies the fact that the earth's surface varies in many ways which have their effect on wind flow. The greater part of it is water. This absorbs far more heat, and so reflects back to the atmosphere far less heat than land. Consequently, in summer the air over the sea is usually cooler than over the land; but in winter the case is reversed, since the seas continue to give up to the air the heat they have accumulated in the summer, whereas the land has no such store, having given it up more quickly. To a lesser extent the same is true of day and night—and this causes the land and sea breezes which we so often notice when we stay at the seaside in summer. In the day-time the air over the land is quickly heated and rises, so that we feel as a sea breeze the cooler air which flows in from the water to take its place. At night the land cools off quickly, whereas the sea continues to give up its heat slowly so that the air above it expands and rises, causing an off-shore breeze as the land air takes its place. It is for a similar reason that any wind tends to die away at sunset and dawn—or at least to be much reduced in speed.

Over dry land the air is usually heated by the sun far more unevenly—as well as more quickly—than over water. This is because the amount of heat reflected back varies with the nature of the land. Trees and dense vegetation absorb much more (and, consequently, reflect back much less) heat than such surfaces as desert sands, rocks, roofs, and roads. So over continents and islands the uneven heating causes expansion and low-pressure areas, which may be anything in size from an airpocket or 'bump' felt by an airman to a 'cyclone' (*see* WEATHER). Over land or sea, CLOUDS (q.v.) may intervene to cut off the sun's rays in small patches or huge areas, and so complicate the heating pattern still more. Remembering that winds are caused by air moving in from high-pressure to low-pressure areas, and that low pressure is caused by heating and consequent expansion, we can now understand the great and continual modifications which actually affect the main wind currents shown in Fig. 3. How they

actually blow, in January and in July, is shown approximately in Figs. 4 and 5.

There is one other point to be considered — the effect on the wind of friction against the earth's surface. No forms of matter can move in contact with each other without producing friction, which uses energy and so reduces speed. Even over the comparatively smooth surface of the oceans, the wind is slowed up by friction against the water. On land, where trees, houses, hills, and mountains can interfere with the air-flow, the effect is greater still. Roughly speaking, over the sea the speed of the wind 2,000 feet in the air is likely to be about half as fast again as at sea-level, and over the land it may well be three times as great. It is not only the speed which is affected, the direction, too, is probably changed—either by obstacles such as hills, valleys, and mountain ranges which set up what is called 'turbulence', or by the drag of the earth's surface caused by the speed of [illegible] [illegible]tion, as described in our second parag[illegible] [illegible] When airmen make long flights out of [illegible] [illegible] the ground, great care has to be taken [illegible] [illegible]ade them as accurately as possible with [illegible] [illegible] the force and directions of the winds the[illegible] [illegible]ely to fly through. A wind which chan[illegible] [illegible]urse in the direction of the sun's rotation [illegible] [illegible]se is said to 'veer', a wind changing in [illegible] [illegible]osite direction (anticlockwise) is said to '[illegible]'.

The speed of the wind can be [illegible] [illegible]d in miles per hour (as measured by an [illegible] [illegible]ent called an ANEMOMETER (q.v. Vol. [illegible]) or described by its 'Beaufort Number' on [illegible] [illegible]al scale arranged by Admiral Beaufort [illegible] [illegible] for the use of sailing-ships. The mode[illegible] [illegible]orm of this is given below.

WISCONSIN, U.S.A., *see* UNITED [illegible] OF AMERICA.

The Beaufort Scale of Wind Force

Beaufort number	Limits of velocity in m.p.h. at 33 ft. above level ground	Description of wind in forecasts	Noticeable Effect of Wind: on land	at sea
0	Less than 1	Calm	Smoke rises vertically.	Sea is mirror smooth
1	1–3	Light	Direction shown by smoke-drift, but not by vanes.	Small wavelets like s[illegible], but no foam crests.
2	4–7	,,	Wind felt on face; leaves rustle; wind vanes moved.	Waves are short and [illegible] pronounced.
3	8–12	,,	Leaves and twigs in motion. Wind extends a light flag.	Crests begin to brea[illegible]. Foam has glossy appearan[illegible] not as yet white.
4	13–18	Moderate	Raises dust, loose paper, and moves small branches.	Waves are longer. Man[illegible] white horses.
5	19–24	Fresh	Small trees in leaf begin to sway.	Waves are more pron[illegible]nced; white foam crests seen everywhere.
6	25–31	Strong	Large branches begin to move. Telephone wires whistle.	Larger waves form. Foam crests more extensive.
7	32–38	,,	Whole trees in motion.	Sea heaps up. Foam begins to blow in streaks.
8	39–46	Gale	Twigs break off. Progress generally impeded.	Waves increase visibly. Foam is blown in dense streaks.
9	47–54	Gale	Slight structural damage occurs. Chimney-pots removed.	Waves increase visibly. Foam is blown in dense streaks.
10	55–63	Strong gale	Trees uprooted. Considerable structural damage.	High waves with long overhanging crests. Great foam patches.
11	64–75	,,	Damage is widespread, seldom experienced in England.	Waves so high that ships within sight are hidden in the trough. Sea covered with streaky foam. Air filled with spray.
12	above 75 m.p.h.	..	Country-side is devastated. Winds of this force are only encountered in tropical revolving storms.	..

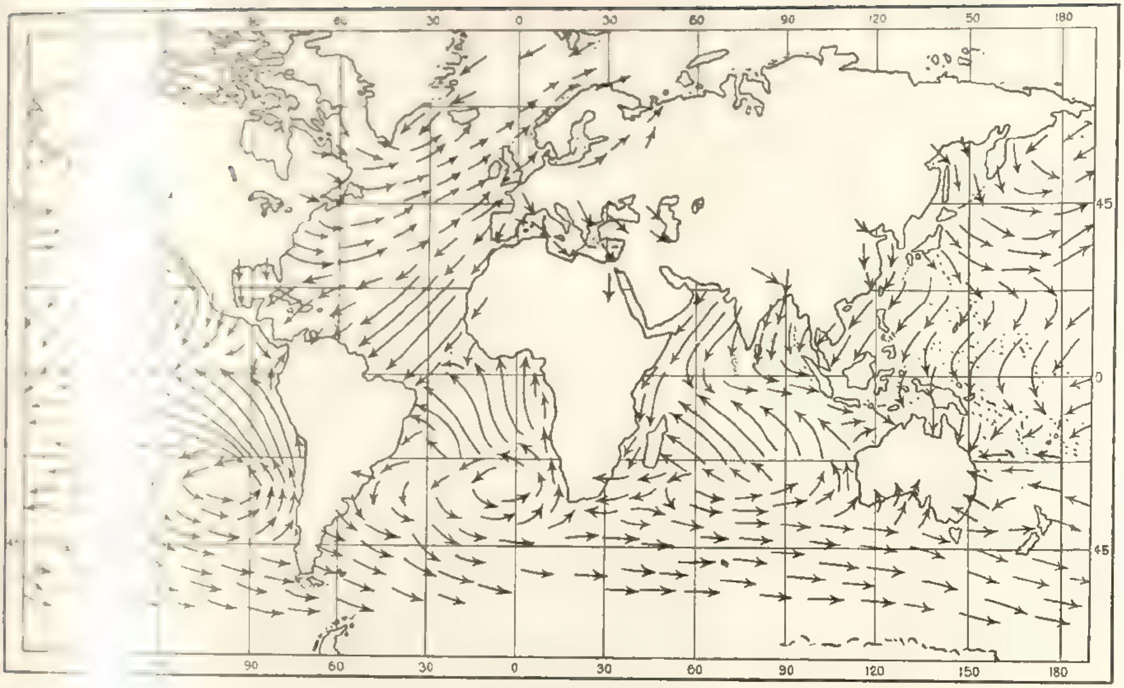


FIG. 4. WORLD WINDS IN JANUARY

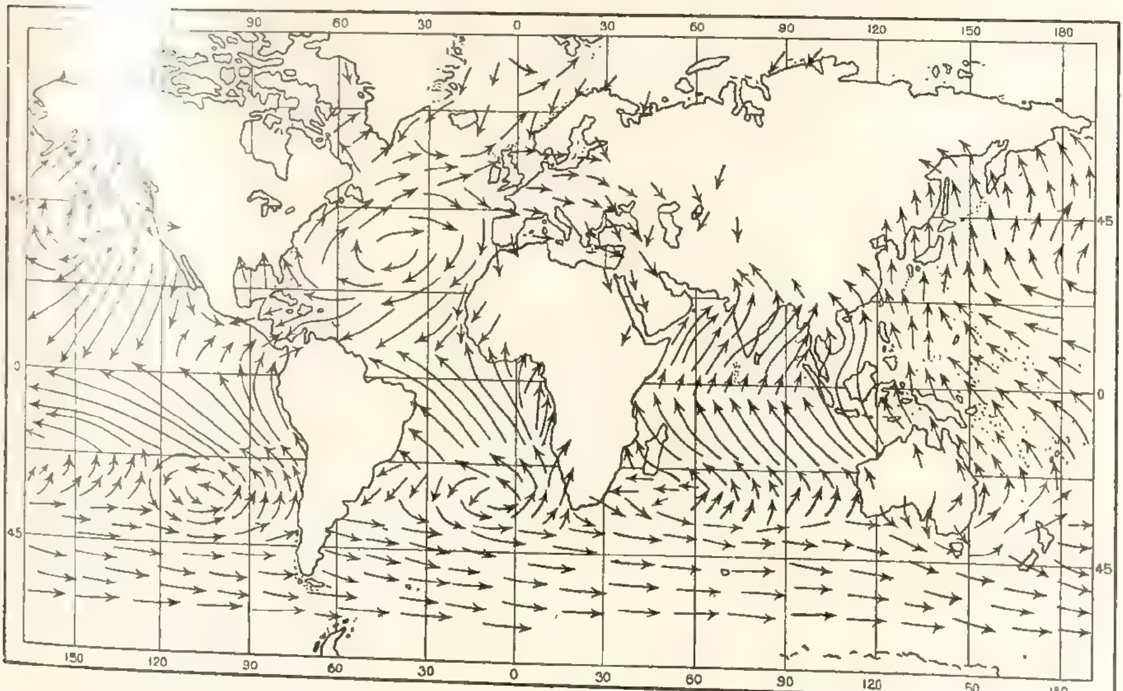


FIG. 5. WORLD WINDS IN JULY

Y

YANGTZE RIVER. The Yangtze River or Yangtze Kiang is about 3,500 miles long, and the longest river in all Asia. It supports more human life than any other river in the world, for over 200 million people live on the land it drains and waters.

The Yangtze rises in the high plateau of Tibet (q.v.), a nursery of great rivers, and races for the first half of its course through mountains, cutting its way along deep narrow ravines until it reaches the entrance to the Red Basin of Szechuan. Then it slows down and becomes navigable, being about 600 yards wide and 20 to 30 feet deep. Near China's war-time capital, Chungking, it cuts through the famous Yangtze

ONE OF THE GORGES OF THE YANGTZE RIVER

Gorges between cliffs up to [illegible],000 feet high, and is full of dangerous rapids. Ichang [illegible] eastern end of the Gorges, and there [illegible] the wide lake-studded, alluvial low[illegible] Central Basin of China. At Ichang [illegible] 130 feet above sea-level and 1,000 [illegible] the sea. It leaves the Central Basin [illegible] valley which continues north-east to [illegible] where the delta begins.

In its lower course it forms one of [illegible] waterways of the world. Ocean stea[illegible] in summer steam 600 miles upstre[illegible] inland port of Hankow), river-steamer[illegible] and innumerable junks carry the trade of [illegible] up and down the river. Till half a ce[illegible] steamer traffic stopped at Ichang at th[illegible] but to-day high-powered launches b[illegible] way through rapids where the current [illegible] at 14 knots. Sailing junks still negoti[illegible] the Gorges in the old way, towed upstre[illegible] by struggling teams of trackers, clinging [illegible] to ledges cut in the cliffs. Shipwrecks ar[illegible] very frequent.

Many millions of Chinese live by g[illegible]ing rice, tea, sugar, tobacco, and other crop[illegible] the fine red soil of the Red Basin of Sz[illegible] made rich by silt brought down by the Y[illegible]tze at the rate of some 600 million tons a ye[illegible] The volume of water in the river varies enor[illegible]ly with the seasons. When the snows are [illegible]ting in Tibet, and the monsoon rains are sw[illegible]ping the lower valley, the level in the narro[illegible] may rise by as much as 80 feet, and floods ma[illegible] sweep over the plain, bringing disaster and d[illegible]h to millions of Chinese. Luckily, nature h[illegible] provided a 'safety-valve' by creating ov[illegible]flow-reservoirs in the form of the series of great shallow lakes of the Central Basin.

Such a volume of swift-flowing water offers marvellous opportunities to water-power engineers, and plans have already been worked out for harnessing the river at the Gorges. If the money can ever be found to finance the scheme, China may have the biggest hydro-electric installation in the world.

See also CHINA; RIVERS.

YEAR, *see* CALENDAR.

YELLOW RIVER (HWANG-HO). This great Chinese river rises in the highlands of Tibet, and in its long course of almost 3,000 miles to the sea crosses desert, cuts through gorges, and winds

NATIVE BOAT ON THE YELLOW RIVER

E.N.A.

across [illegible] broad flat delta. From Tibet to Lanchow [illegible] a foaming, tortuous torrent. At Lanchow [illegible] turns north in a great loop, part of which [illegible] outside the Great Wall of China in the sand[illegible] Mongolian steppes. At Lo-chow it is joined [illegible] its biggest tributary, the Wei-ho, which [illegible] a long loess-filled depression of [illegible]. The combined rivers cut through mountains [illegible] to Kaifeng, where the flood-plain of the [illegible]. The Hwang-ho carries a great deal [illegible] silt which gives it a muddy yellow colour– hence its name.

Unlike the YANGTZE (q.v.) the Yellow River is [illegible] use for transportation. The great Ordos [illegible] into Mongolia is used by flat-bottomed boats and rafts of inflated skins, and small craft can navigate some of the lower reaches, but in most parts there are too many rapids or sand-banks. Unlike the Yangtze, too, its banks are shunned for fear of its terrible floods– instead of being crowded by cities and villages.

The floods are due to three things. In spring the river is swollen by the sudden melting of ice in the mountains (its upper drainage area), and in summer by violent rainstorms. It then crosses bare, treeless, loess areas which gully easily and do not slow up the sweeping floods. The third reason is that by carrying down vast quantities of silt, it causes a constant raising of the river-bed– so much so that in the plain, the river flows like a mighty aqueduct above the level of the surrounding country, held in by man-made dykes. In some places it is 15 feet above the plain at low water and 30 feet at high. Occasionally the dykes give way and the waters rush over the plain, swamping the fields and villages, and the task of 'harnessing the dragon' has to begin over again.

After a bad break-through, the river is apt to abandon its old bed and create for itself a new channel to the sea. This has happened many times in its history. Sometimes the lower course has been north of the Shantung peninsula, the rocky wedge of land that projects towards Korea, and into the Gulf of Pohai or Pei-chih-li, while at other times it has skirted the southern side of the peninsula and flowed out into the Yellow Sea. At the present time it follows the northern course.

See also CHINA; RIVERS.

YEMEN, *see* ARABIA.

YORK (pop. 105,340) lies 188 miles north-west of London at the junction of the three Ridings of Yorkshire, the largest county in England. Its situation in the low-lying vale of York, where the Ouse is joined by the Foss, is at the crossing of the two natural main routes of the area: north–south along the waters of the Ouse, east–west along the York moraine ridge, cut by the river and parallel with the gap in the Pennines. Though it is not mentioned in Domesday Book, York was already an important place during the Roman occupation of Britain, the military headquarters of the Sixth Legion (Victrix) and the site of a flourishing municipality. The Emperor Constantine the Great was inaugurated there in the early part of the 4th century. Since then its central position has assured it a recurring place in English History. There was a bishop of York as early as 314. Harold took it in 1066, and in 1069 the men of the North rose against the Norman garrison and massacred it, calling down the devastating vengeance of William the Conqueror, who burnt the city and laid waste all the country between it and the Tweed. Several important Parliaments were held there in the Middle Ages, and in the Civil Wars the town was held by the Royalists until after the battle of Marston Moor.

Since the subdivision of Yorkshire, York has lost much of its administrative importance as a capital city. It is, however, an important railway centre, the Headquarters of the NE. Military Command, and an industrial city of some importance, connected by the River Ouse with the Humber and the sea. York is also the centre of the archdiocese of northern England—there has been an archbishop of York since 627.

The main glories of York are in the past. Its many narrow medieval streets and gates (called Bars), and its almost complete circuit of 14th-century walls, make it a happy hunting-ground for those interested in history. Above all looms the Cathedral, known as the Minster, the largest medieval church in England and one of the finest. The Minster shows the whole growth of English architecture, from Early English to late Perpendicular, blended into an harmonious and magnificent whole, and lit within by a unique display of English stained glass.

YUGOSLAVIA. The 'Country of the Southern Slavs', the Serbs, Croats, and Slovenes, was formed in 1919 by uniting Serbia and Montenegro together with territories which had belonged to the Austro-Hungarian Empire—Croatia, Slovenia, Dalmatia, Bosnia, and Herzegovina. It is the largest country of the Balkan Peninsula, with a population of fourteen millions, and, given peace and security, could become prosperous, for there is much fertile land, mineral wealth still undeveloped, and magnificent forests. The west and south are mountainous; in the north-east is part of the vast fertile plain of the middle Danube (*see* Map, p. 160).

The Dinaric Mountains occupy west and central Yugoslavia. They run from north-west to south-east and are high and rugged, the main chains rising to over 8,000 feet above sea-level. Near the coast they are of limestone, and are either high steep ranges cut by deep gorges, or rocky barren plateaux which look like white, desolate, stony deserts. These plateaux in the Karst district of Dalmatia are pitted with roughly circular hollows, which may be lakes in winter and cornfields in summer. There are very few surface rivers, and the few that exist run in deep narrow gorges and often disappear in holes in the ground to reappear, some miles away, out of a cave or a crack in the rock. This kind of limestone country is now called 'karst' wherever it appears.

The Dalmatian Islands off the coast are the ridges of limestone country which has been submerged, and they are ranged in lines roughly parallel to the coast. The coast is outstandingly beautiful, both in natural scenery and in its lovely medieval towns. Sometimes the mountains drop steeply to the sea in dazzling white or yellowish cliffs, or in dark green or greyish-green wooded slopes, or in terraces planted with vineyards and orchards. Sometimes there are narrow coastal lowlands. At Cattaro in the south is the famous 'Bocca', a great fiord which runs inland between high mountains, branching into five gulfs.

Eastern Yugoslavia includes parts of the Rhodopi and CARPATHIAN MOUNTAINS (q.v.). These mountains are high and steep and often rugged, and are cut in different directions by deep gorges. The DANUBE (q.v.) flows in one of these gorges, called the Iron Gates, which cuts through the Carpathians. In the north-west corner of Croatia is the beautiful lake district of Plitvica, where the lakes, embedded in forested hills, cascade into each other by waterfalls—for there is a difference of nearly 400 feet between the highest of the thirteen principal lakes and the lowest.

The great plain of Yugoslavia is part of the plain of the middle Danube. It is not absolutely flat, as there are small hilly areas and flat terraces which drop to the marshy flood-plains of the rivers by steep edges. Maize and wheat are the chief crops, and in early autumn the long pods of maize are hung up to dry on the walls of the farm-houses and cottages, making them look as if they had been faced with gold. On the lower slopes of the hills round the plain are plum and apple orchards, vineyards, and vegetable gardens. On the higher slopes are forests. Felled tree trunks are slid down the mountain sides to the streams, where they float to the Danube and its wide tributaries. There they are made into enormous rafts, on which the men who steer them live during the long voyage to the ports of the lower Danube or to the Black Sea.

The climate of Yugoslavia is very varied. The coastal areas have a Mediterranean climate with mild, rainy winters and long, very hot, dry summers. In autumn the weather is often very stormy and rainy, and is accompanied by the

MOSTAR, ON THE RIVER NARENTA, IN WESTERN YUGOSLAVIA

Bora and the SIROCCO winds (q.v.). In the Dinaric Mountains there is an exceptionally heavy rainfall, and in winter very heavy falls of snow. Eastern Yugoslavia has cold winters and very hot summers, and there is rain at all seasons. The plains in the north have cold winters with bitter winds, and hot, dry summers broken by severe thunder-storms.

The capital, BELGRADE (q.v.), 'The White Town', stands on a low spur at the junction of the Danube and the River Sava. It is a meeting-place of routes from all parts of south-western Europe, and has, since the dawn of history, been beseiged, destroyed, and rebuilt many times. Zagreb, the capital of Croatia, has managed to become modern and industrial, and at the same time to keep its historic character. Ljubljana, the capital of Slovenia, is on the Roman road to Vienna. The old town with its fortress is on the hill, while the modern town is on the plain below. The lovely towns along the Dalmatian Coast and on the islands—Šibenik with its great cathedral, Rab with its high walls and crown of towers, Split built into the ruins of the palace of the Emperor Diocletian, Dubrovnik with its complete circle of walls and forts—all show the influence of their near and jealous neighbour VENICE (q.v.), once mistress of the Adriatic. Sarajevo, the capital of Bosnia, the meeting-place of east and west, of Christian and Turk, is famed for its beautiful mosques and Turkish houses. Cetinje, the capital of Montenegro, is an unimposing Turkish-looking little town, reached from the coast by a magnificent mountain road, built by Napoleon, which rises from the end of the Cattaro Bocca in a series of tremendous hairpin bends. At Skoplje, in southern Serbia, the minarets look down on the Roman bridge and fort, while Okhrid, with its narrow winding streets and tiny 12th-century churches, stands on a lake on which are still used heavy boats hollowed out of a single tree-trunk.

See also Vol. I: YUGOSLAVS.

Z

ZAMBESI RIVER, *see* Rhodesia; Victoria Falls.

ZANZIBAR. The British Protectorate of Zanzibar is made up of a narrow strip on the east coast of Africa and the islands of Zanzibar and Pemba, with many neighbouring islets (*see* Map, p. 5). Zanzibar, which lies in the Indian Ocean about 25 miles off the coast, is about 48 miles from north to south and at its widest is 15 miles across. Thirty-five miles to the north-east is Pemba, which is 40 miles from north to south and 4 to 10 miles wide. Zanzibar is hilly and fertile in the west, fairly flat and barren in the east. The hills are roughly parallel north–south ridges, separated by valleys. Pemba is hilly, and more broken with fairly deep valleys and ravines. Both islands fall to the sea by low, honey-coloured limestone cliffs fringed by reefs and islets. On one of the islets, Mesali, the famous pirate, Captain Kidd, is said to have hidden his treasure.

Climate is tropical. The hot season lasts from November to early April. In the fertile areas of both islands crops of many kinds are cultivated, but by far the most important commercially is the clove-tree. As the Zanzibar islands are the only place in the world where the clove-tree flourishes, they produce the major part of the world's supply. Cloves as we know them are the dried buds of the tree. Other crops are sugar, rice, tobacco, coco-nuts, fruits of many kinds, maize, manioc, and beans. Goats are kept. Fishing is very important and turtles are common on many islands. Wild animals include pigs, monkeys, lemurs, and mongooses; and there are pythons and countless beautiful tropical birds.

Zanzibar is the only town of any size. It has an excellent harbour which is used by ocean liners as well as by Arab *dhows* with striped sails. It is an eastern city, with narrow streets lined by high Arab houses—but they are lit by electricity, and the two Cathedrals, the government offices, the museum, and the numerous tennis-courts are further evidence of the city's up-to-date character. Villages are usually groups of thatched, rectangular houses set picturesquely amid palm-groves and orange-gardens. The inhabitants of Zanzibar are mainly Swahili-speaking Negroes (*see* Negro Africans, Vol. I), though the ruling class are for the most part Arabs (q.v. Vol. I).

See also East Africa.

ZENITH, *see* Astronomical Measurements, Section 2.

ZINC, *see* Metal Ores.

ZIRCON. This semi-precious stone is becoming very popular as a gem-stone. It occurs in many colours and, consequently, under a variety of names. Reddish stones are called 'hyacinths' or 'jacinths'; pale-yellow stones are 'jargoons'; colourless stones are sometimes known as 'Matura diamonds' because they are mined in Ceylon and were thought once to be diamonds; and blue stones are known as 'starlites'. There are also green zircons. All are four-sided crystals—though, as zircons are often found in gravels, many are worn to rounded pebbles.

Natural colourless or blue stones are rare; but some brownish zircons when heated to a very high temperature become blue or colourless. When the brownness comes back, as it will do, the process can be repeated.

See also Minerals; Colour Plate opp. p. 288.

ZODIAC, *see* Constellations; *see also* Vol. I: Astrology.

ZULULAND, *see* South Africa; *see also* Vol. I: Zulus.

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